WIRED

UK EDITION

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Plus

THE HEADPHONE STARTUP THAT TOOK ON APPLE

WIRED'S 2016 TRENDS BRIEFING

BY MELINDA GATES, ALAIN DE BOTTON, STEFAN SAGMEISTER, YVES BEHAR... AND MORE

HE ALREADY OWNS WHATSAPP.

SO WHY IS ZUCK PUSHING MESSENGER SO HARD?

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Driving Machine

Official fuel economy figures for the new BMW 7 Series Saloon range: Urban 29.1 – 51.4mpg (9.7 – 5.5 l/100km). Extra Urban 51.4 – 67.3mpg (5.5 – 4.2 l/100km). Combined 40.4 – 60.1mpg (7.0 – 4.7 l/100km). CO_2 emissions 164 – 124g/km. Figures may vary depending on driving style and conditions.

BMW LASERLIGHTS.

BMW Laserlight technology extends the headlight's high-beam range to up to 600 metres, doubling the already impressive illumination range of the latest LED headlights.

INTERIOR COMFORT.

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CARBON CORE.

The BMW 7 Series has a revolutionary Carbon Core; lighter than aluminium or steel, yet with the same rigidity and strength. Inspired by the pioneering technology of BMW i, it creates a strong, lightweight centre for the car and a balanced, exhilarating drive.

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007

IN CINEMAS

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biOMASON CEO Ginger Dosier with a pallet of the startup's lab-grown bricks

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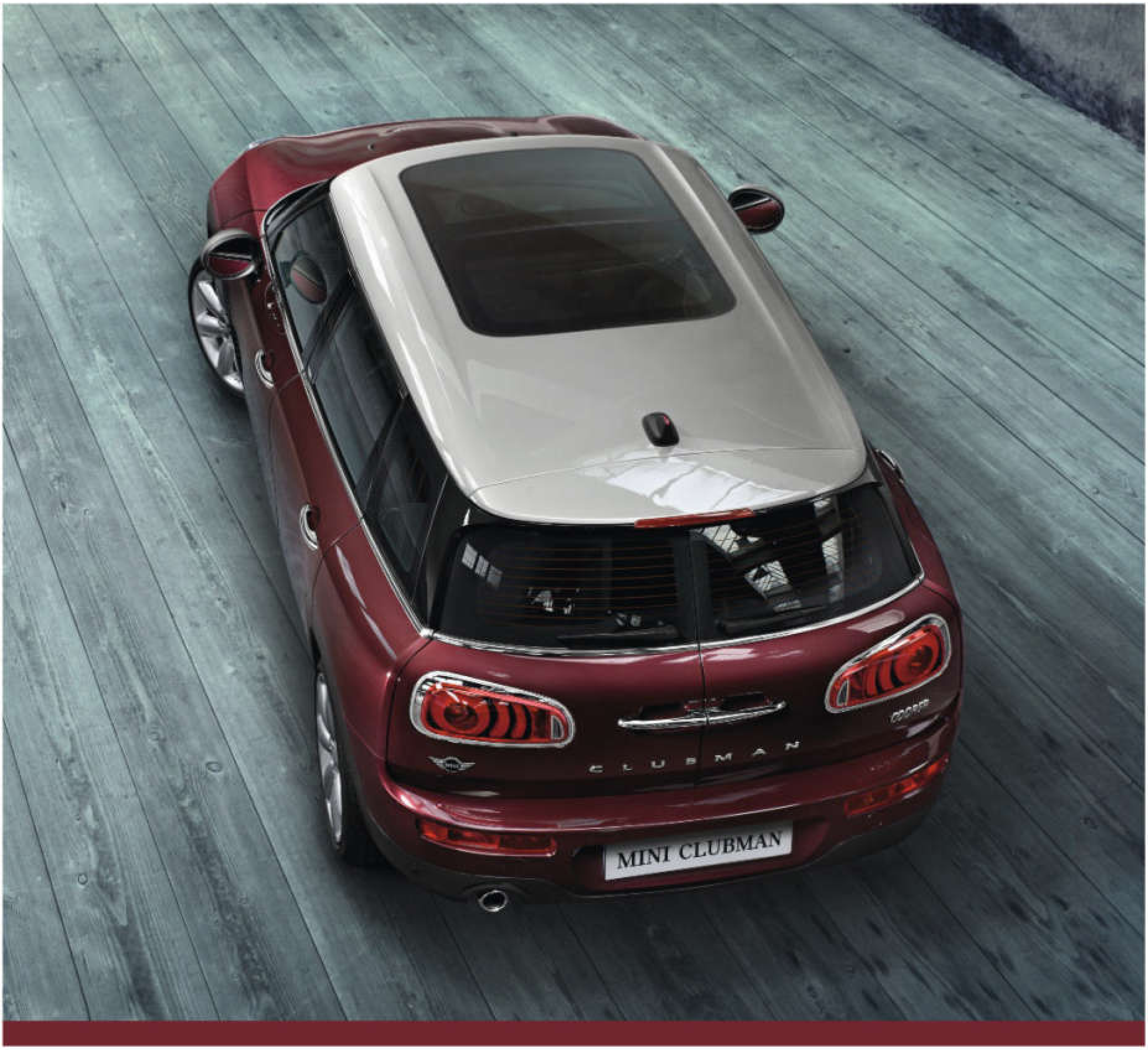
START

Bricks from bugs

Biotechnology startup bioMASON is cutting building blocks' CO_2 impact – by growing them on-site using bacteria



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How Ustwo, the London-based team behind *Monument Valley*, turns its award-winning design into art

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One app to run your life

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PHOTOGRAPHY: SPENCER LOWELL

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MIKE MCQUADE

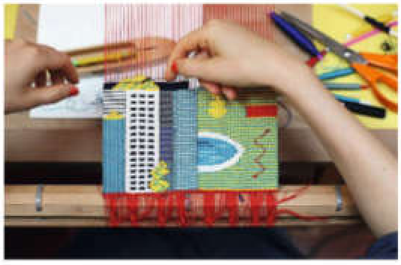
Chicago-based artist McQuade spent hours scanning images to create the opener for our From share to snare feature. "After reading the piece, I realised how public posting on social media can easily be used against you – in more ways than one," he says.

MELINDA GATES

In our WIRED *World in 2016* preview, Melinda Gates argues that data has the power to transform global development. "It's inevitable that data will continue to play an increasing role in progress," she says. "We just have to continue to tell the success stories."

DAVID BAKER

WIRED contributing editor David Baker spent time with the Bragi team as they were preparing to launch The Dash, its wearable device. "It's ingenious," he says. "It's larger than I had imagined but much less ridiculous than Google Glass. It will be a huge success."



WEAVING FOR WIRED

For this month's Features opener, artist and designer Hannah Waldron hand-wove a mini tapestry just for us. "It's the exact size of a page of the magazine – I wanted it to be as close to real life as possible," she says. "I like the idea of it counterbalancing WIRED's digital aspects." And her dream commission? "Seating textiles for London transport, the city in which I grew up."

Blame the tester, not the product

PHOTOGRAPHER WITH ALTITUDE

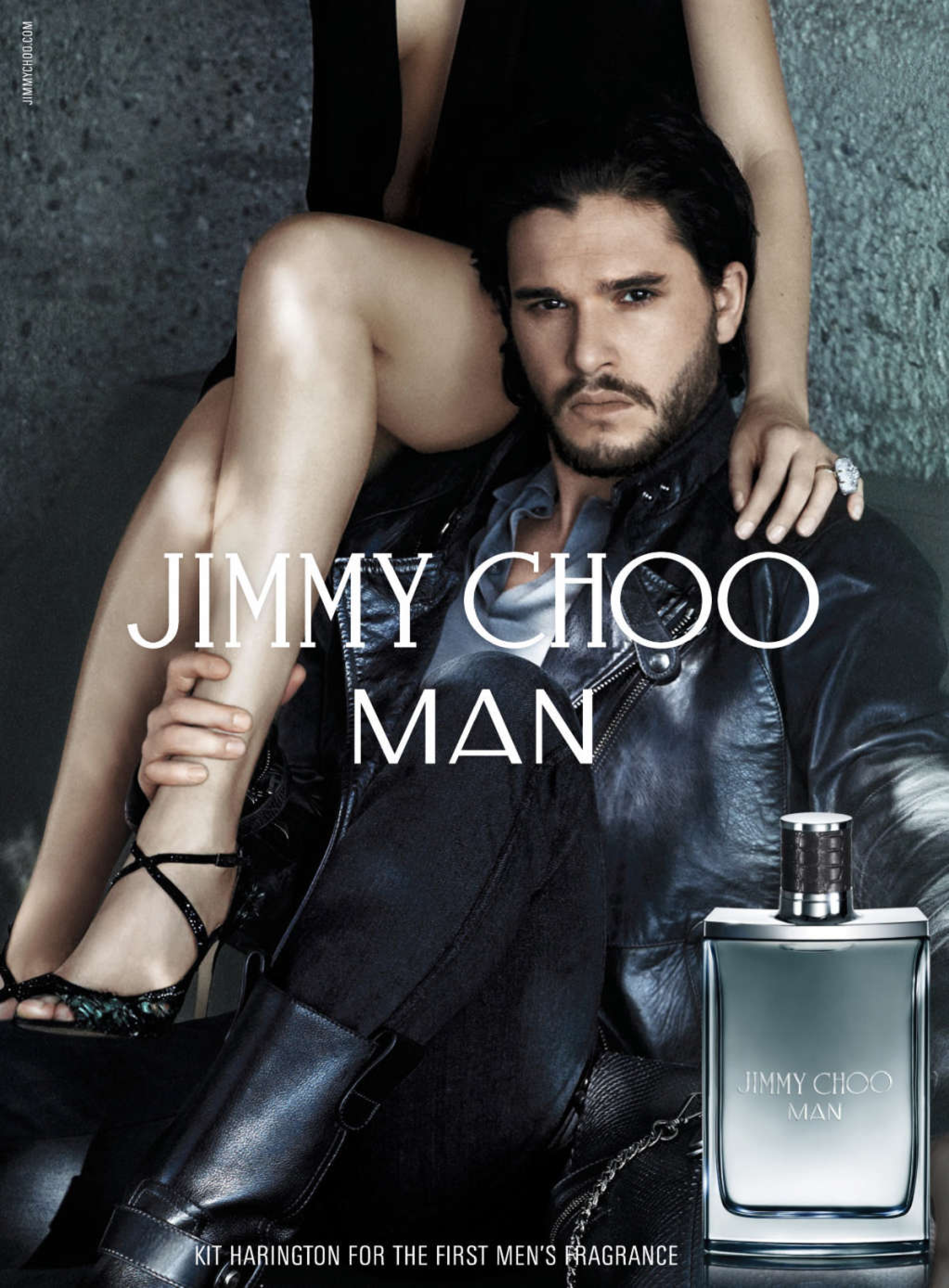
Christoph Oberschneider travelled to the Austrian slopes for our Gear snow special. "Working at such high altitudes was fun but quite exhausting," says the photographer. "I got the chance to try the Sony action cam and would have loved to try the goggles with integrated display too, but writers Jeremy (*above*) and Henry were way too busy using them to check their maximum speeds." Perhaps Jeremy should have spent more time trying to stay on his feet…

SPENCER LOWELL

LA-based photographer Spencer Lowell went behind the scenes at Facebook's Frank Gehry-designed HQ this month. "The vast space was free-flowing and seemed to encourage collaboration," he says. "It's like other tech companies, but on a much grander scale."

JAMIE BARTLETT

In Ideas Bank, Jamie Bartlett talks about the rise of the dark net. What does he think will be its tipping point into mass adoption? "No one single thing, but it will reach an exponential momentum as happened in the 90s with the internet itself," he says.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LACKING THAT HUMAN TOUCH

"As demonstrations of sculpture, moulding with rubber and reproducing skin colour and texture, humanoid robots are masterful accomplishments (Uncanny valley robots will really creep you out, wired.co.uk). As simulacra of human movement, however, they're laughably unrealistic. Hollywood animatronics and old-fashioned puppetry are both capable of more smooth and nuanced movement." **Michael Smith, via Facebook**

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MAGAZINE

THANKS FOR THE MEMORIES

"I am a memory athlete and a fan of memory sports since 2003, and this is by far the best article I have ever read about it (The Memory Games, WIRED 09.15). Well done. I hope to see more from WIRED about this marvellous sport in the future." **Florian Dellé, via Facebook**

TWITTER

PRINT TWEET, KILL FLY

"Don't let print media die! I just used a rolled-up copy of WIRED magazine to kill two small flies because I wanted to sleep in peace." **@Uyeda98**

How IKEA designs
FROM 3D-PRINTED CHAIRS TO ENDLESS KITCHENS, THE WORLD'S BIGGEST FURNITURE RETAILER IS REASSEMBLING THE FUTURE. WIRED VISITS ITS LABS IN SWEDEN AND SHANGHAI

MAGAZINE

WELL-MADE

"@WiredUK on the money with the Design Issue. It landed the same day as the @google redesign. Amazing." **@kev_mcdougall**

Want to air your views on WIRED?
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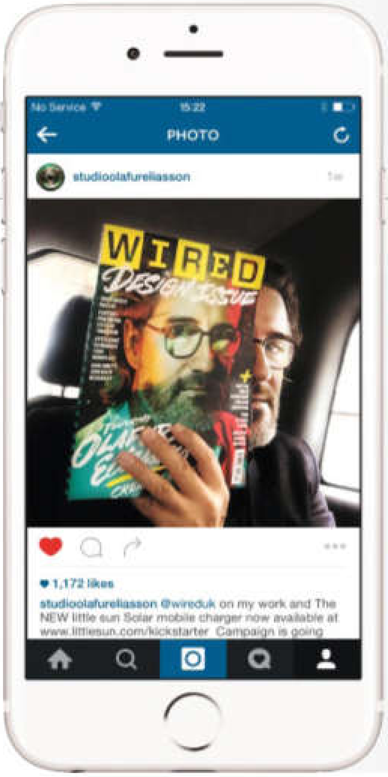

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MAGAZINE

A MOMENT OF REFLECTION

"The Design Issue has finally landed in our studio! Olafur Eliasson was in London yesterday and managed to pick up a copy #connectedbythesun." **Alice Broughton, via email**

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FROM OUR MESSAGEBOARDS

'I have never felt more isolated'

***Minecraft* creator Notch on unhappiness despite his fortune (wired.co.uk)**

"Dude, you could take all that money and invest in long-term projects, whether those be in gaming or not. Take some management or social classes at a local college (or even the Ivy Leagues, you've got the money) and put that cash to good use." **Bobby Bell, via Facebook**

"He's a working-class guy who has been vaulted to heights few could dream of, and his working-class motives for doing stuff no longer apply. He needs to spend $110,000 a day for 50 years to burn through $2 billion." **Dale Mahalko, via Facebook**

"In Daisaku Ikeda's words: 'Even a man who has great wealth, social recognition and many awards may still be shadowed by indescribable suffering deep in his heart.'" **Stuart Summer-Smith, via Facebook**

"He seems like a whiny ass." **Brody Edwards, via Facebook**

"Boo hoo, my billions gave me sadbrains! Come on dude, seriously. Give me the money and I'll make quite a few people happy, including myself." **Josh Rivera, via Facebook**

"This comment section is a microcosm of what he experiences every day. No genuine human interaction, no empathy for the problems he might face. Because he has money, and morons think money solves every problem. No wonder he's miserable." **Adam Misosky, via Facebook**

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FROM THE EDITOR

How many notifications have distracted you today? Thirty? Fifty? More? Each one is a reason for you not to be searching Google, shopping on Amazon or browsing the App Store. And that's why Facebook's big new idea is to own the notification process entirely. The reason it pushed you so hard to download *Messenger* is that it wants you to engage constantly with the world's businesses within the app as if they were your friends. And that's an immensely powerful proposition.

I travelled to Facebook's vast new HQ in Menlo Park for this month's cover story to understand why *Messenger* is being seen as the company's next great platform. If retailers, games companies, airlines and pretty much any business can connect with you directly inside *Messenger*, why would you need to download their native app? If you can buy a train ticket, book a restaurant, order a few more T-shirts in the bubbles of a *Messenger* conversation thread, why would you visit Google on the mobile browser? It's a potential lock-in that aspires to the dominance of China's ubiquitous *WeChat* app, but with one crucial difference: in China, businesses pay for their visibility on *WeChat*. Facebook wants everyone on its platform, at no cost at all – apart from the extra advertising it believes it will earn.

Will it work? There's never certainty in messaging, a sector where popular tastes turn quickly and competitors are everywhere (even, with *WhatsApp*, inside Facebook's own ecosystem). But don't underestimate Zuck's determination. He's put some experienced execs in charge, not least PayPal's former boss David Marcus. There's an AI team that's determined to turn *Messenger* into a useful PA (with human employees supplementing its recommendations, bizarrely). And there's the small matter of 700 million people who already use the app each month. If you run a business, you need to start thinking now about your messaging strategy. Because pretty soon, the app era may have moved on.

Stan Chudnovsky, head of product management at Messenger

PHOTOGRAPHY: SPENCER LOWELL

Next month, for the fourth year, we're publishing a separate standalone newsstand (and app) magazine to analyse the trends we see as significant for the year ahead. The WIRED World In 2016, out on November 12, relies on our network of smart thinkers, from Melinda Gates to Dan Ariely, to delve into likely scenarios and opportunities over the next 12 months. We've decided to give you a preview this issue of some of the commentaries and forecasts. And what an amazing group of writers we're honoured to share our own bylines with.

As you read this, I'll be in final planning mode for WIRED2015, our annual two-day ideas festival in London on October 15-16. This week I've had briefings with some of our 50 amazing presenters from around the world, including a North Korean defector, a Colombian peace negotiator and an Indian amputee who climbed Everest. We'll be covering everything from new business models to creative thinking, with special sessions on food innovation and AI. If you can't join us (wired.co.uk/15), follow the event at wired.co.uk.

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David Rowan

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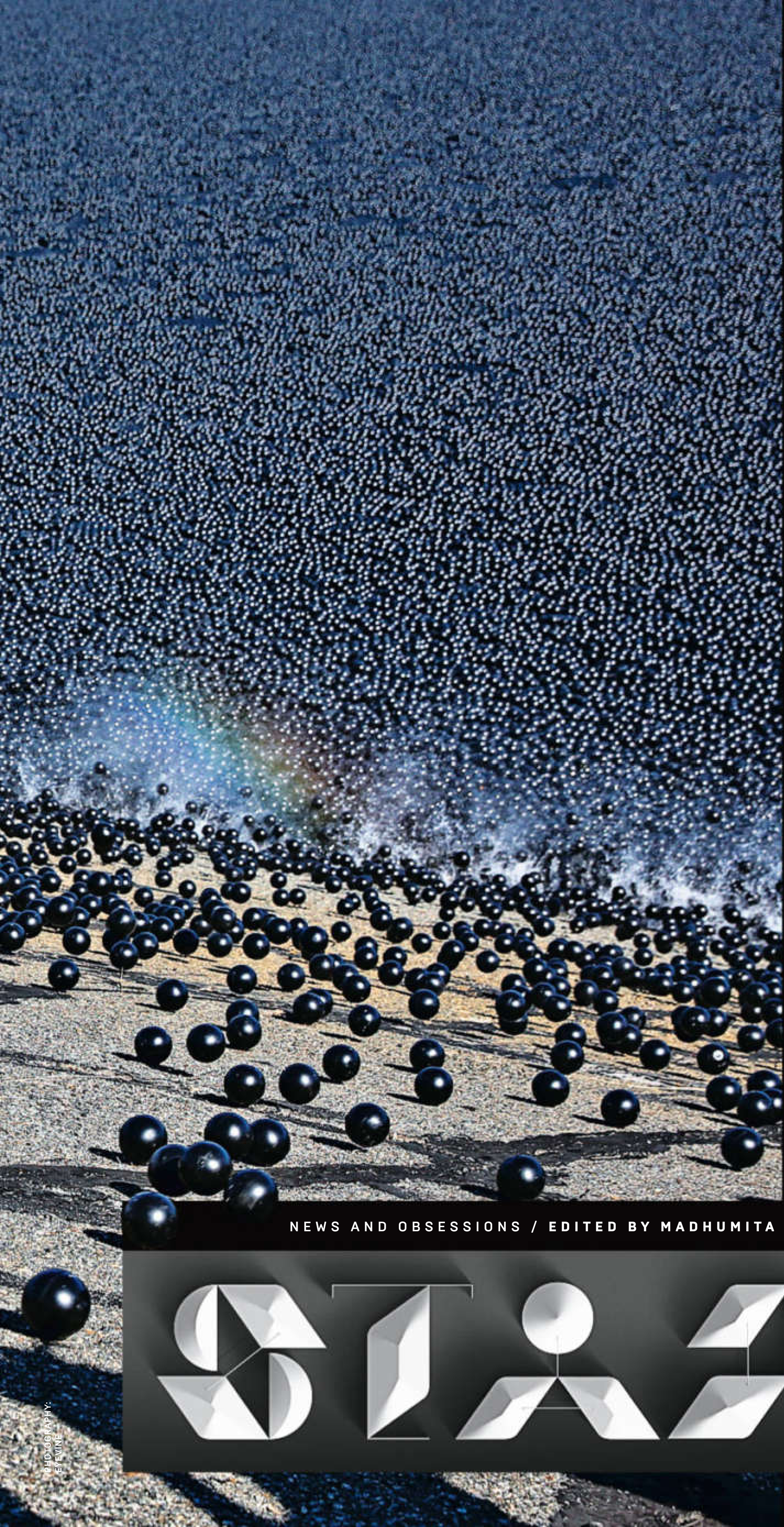
PORSCHE



PHOTOGRAPHY: EYEVINE

START

LA's big cover-up

California's latest water preservation strategy? Ninety-six million small black plastic balls, the last of which were dropped into the Los Angeles Reservoir in August. "Left unchecked, sunlight can promote algae growth in the water," explains Richard Harasick, director of water operations at the Los Angeles Department of Water and Power. "When this mixes with the chlorine disinfectant we use, it causes the formation of carcinogenic by-products."

By covering the surface to prevent sunlight reaching the water, the balls not only halt algae growth, they also stop evaporative loss of up to 1.1 billion litres of water a year. "This is our largest reservoir, which makes it particularly difficult to cover," says Harasick. "A floating cover would have been very expensive." The 10cm-wide plastic balls cost just 36 cents (23p) each, with a total cost of $34.5 million – a saving of more than $250 million.

The idea to deploy the balls came from seeing them used to prevent birds drinking from contaminated ponds. The carbon that gives them their colour will prevent degradation by UV rays, trebling the plastic's lifespan. "This reservoir will have these balls for at least a decade," Harasick says. "Then they'll be replaced with new ones." **Kathryn Nave**

Bricks from bugs

Ginger Dosier is cutting building blocks' CO_2 impact – by growing them on-site with bacteria

BIOTECHNOLOGY STARTUP BIOMASON GROWS BRICKS – WITH THE HELP OF A FEW TRILLION MICRO-organisms. Ginger Dosier, the North Carolina-based company's 37-year-old founder and CEO, hit on the bacterial production process while studying the construction of coral reefs. "I realised that, as with teeth, the building block is calcium carbonate," she explains. "This crystallises as a result of changes in the surrounding pH caused by microorganisms living in the coral."

The bioMASON process begins with sand. It is placed into moulds and inoculated with *Sporosarcina pasteurii* bacteria, which are then fed with calcium ions suspended in water. "The ions are attracted to the bacterial cell walls, creating a calcium carbonate shell which then causes the particles to stick to each other," Dosier explains.

A single bacterial brick takes two to five days to grow, compared with three to five days to make a kiln-fired version. "We can make bricks that glow in the dark, bricks that absorb pollution, bricks that change colour when wet," Dosier says. A pilot plant in Durham, North Carolina, produces 500 bricks a week on average, with capacity for 1,500, and is currently working on an order to pave a courtyard from a Californian estate agent. Dosier's bacteria are also preparing to take on the cement manufacturers, an industry second only to fossil fuels for global carbon emissions. "The advantage of our process is that it doesn't require fuel," Dosier says. The next step is enabling customers to grow bricks on site. bioMASON has two licensees, and is in talks with five more. "We are looking at a powder or syrup that we can ship around the world," says Dosier. "You just add water." **Kathryn Nave** *biomason.com*

CEO Ginger Dosier with one of bioMASON's laboratory-grown bricks

PHOTOGRAPHY: BRYAN REGAN

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The top tech cities

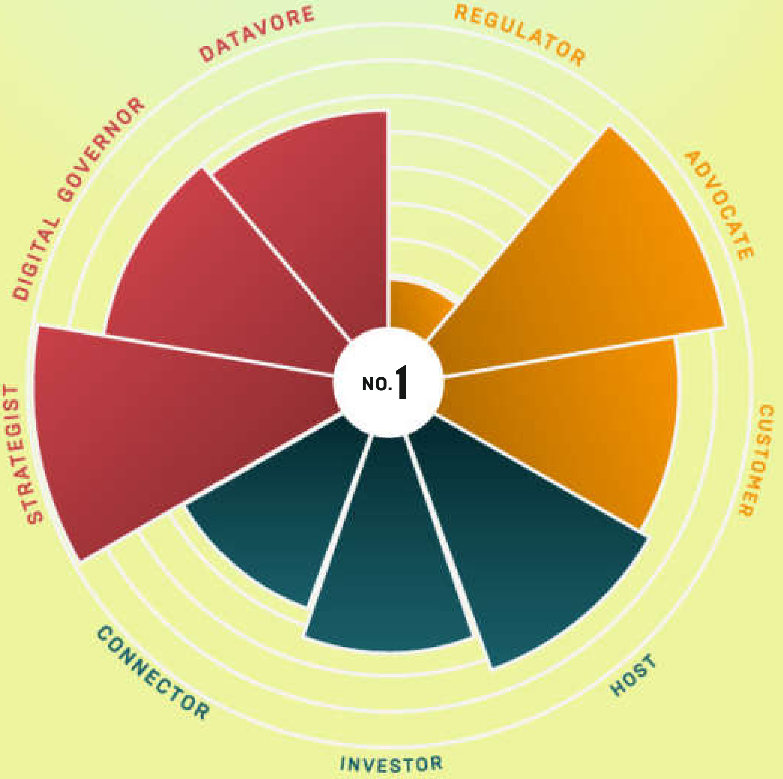
Sorry, London – Nesta says New York out-innovates you

WHAT DO THE WORLD'S MOST innovative cities – from London to Helsinki and Seoul to Amsterdam – have in common? Is it the amount of money invested in local startups, how they regulate new urban businesses or how they use data to govern? UK innovation charity Nesta has been searching for the answer.

"We set out to measure how well city governments are supporting the growth of a tech community," says John Gibson, study co-author and director of government innovation at Nesta. The research team evaluated 40 city governments and analysed 1,440 data points to create an overall top-five list. Then, the 40 were divided into four tiers: experimenters, where new approaches for growth are tested; builders, where an innovation agenda is actively pursued; challengers, where ecosystem growth is being capitalised on; and front runners, where well-established entrepreneurship is built upon and expanded.

According to the report, "CITIE: City Initiatives for Technology Innovation and Entrepreneurship", the top five cities are New York, London, Helsinki, Barcelona and Amsterdam. London lost out to New York for two reasons, says Gibson: "It doesn't have an innovation team in City Hall or a chief technology officer, as many North American cities do. Also, where London put in £1.5 million into digital skills education, New York Mayor Bill de Blasio committed $70m [£45m]." On the plus side, London's open-data policy led directly to startups such as Citymapper. "Citymapper is now in 28 cities. There's a lovely cause and effect there," Gibson says.

For legislators who want to explore the data, the team built an interactive "diagnostic tool" that charts comparative statistics. "We want this to be genuinely useful for policymakers, and to bring to light the most innovative ideas from cities around the world." **MV** *citie.org*



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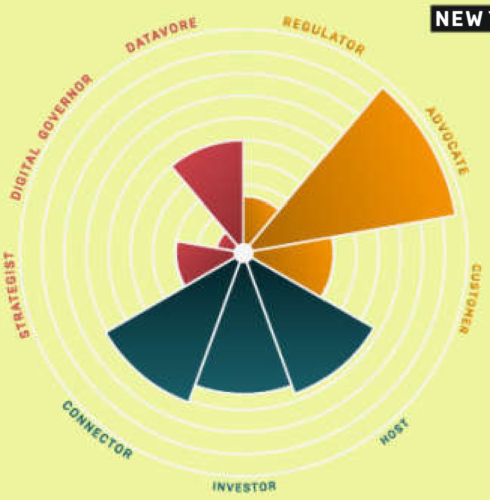
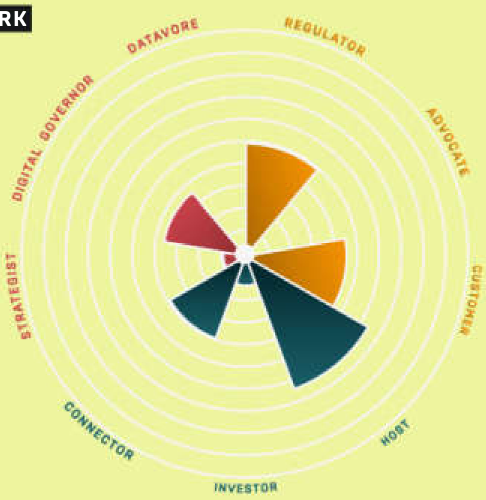
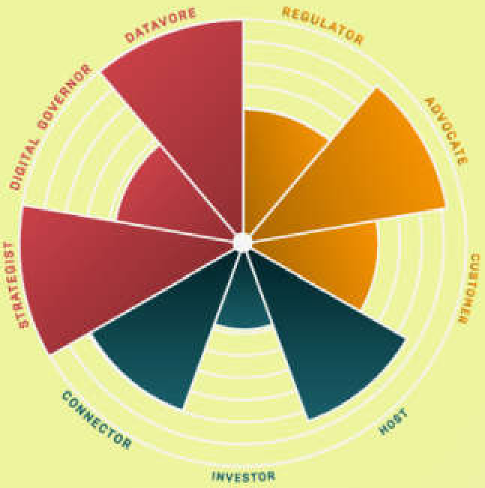


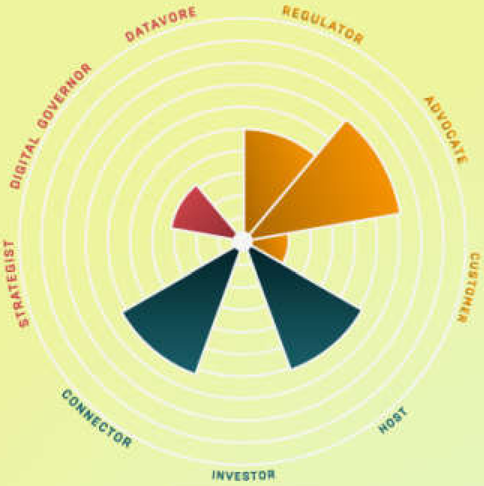
TOP CHALLENGER
BERLIN



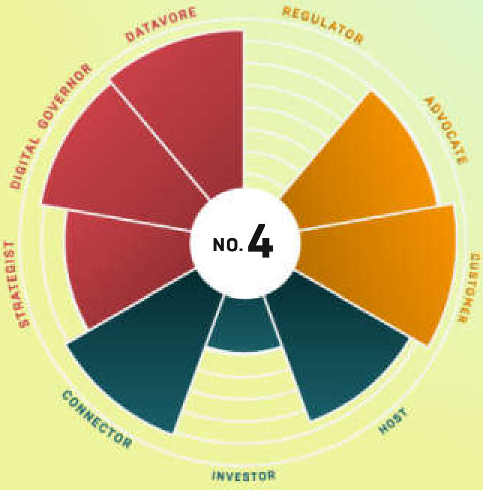
TOP EXPERIMENTER
BANGALORE



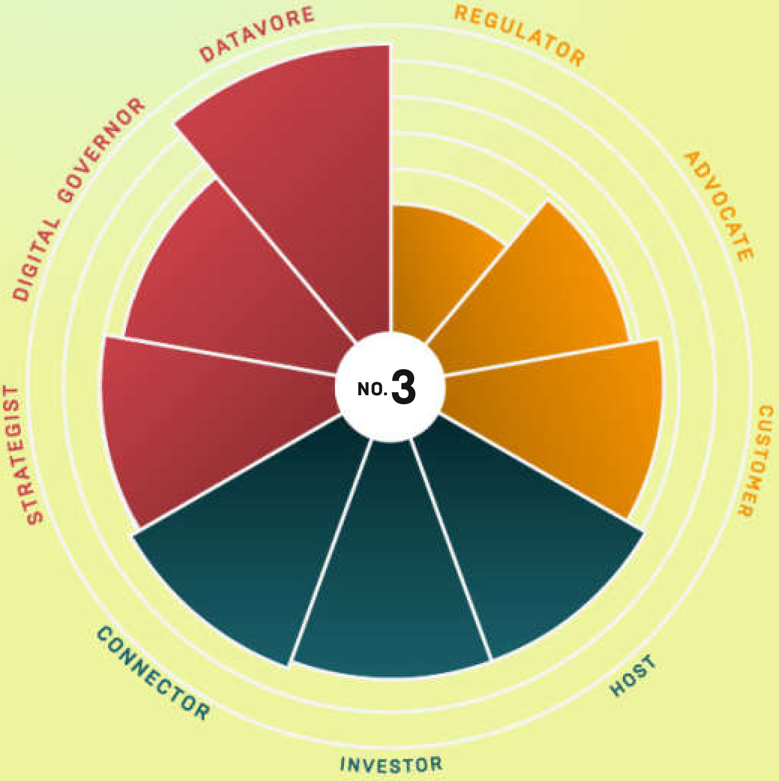
TOP FRONT RUNNER
AMSTERDAM



TOP BUILDER
BOGOTÁ



BARCELONA



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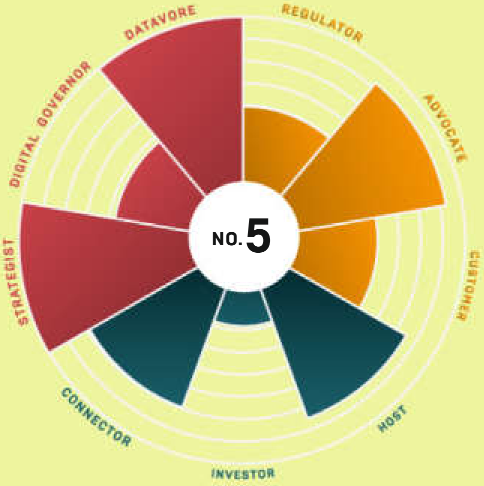

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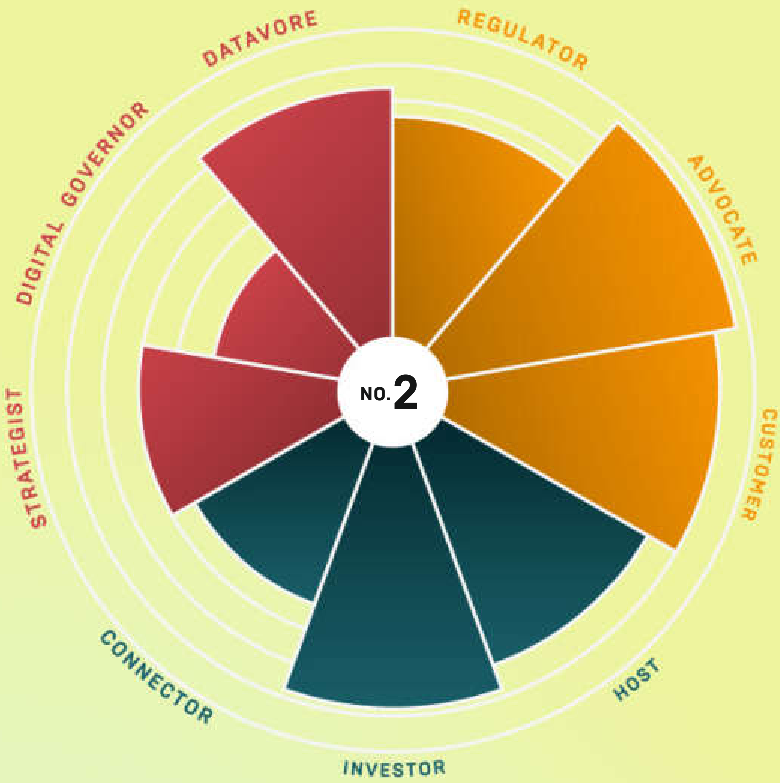
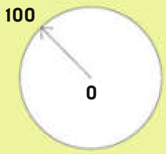
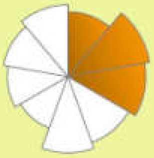


LONDON



KEY

The report scores city governments out of 100 for each of these features:

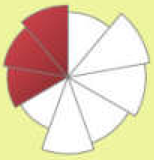


OPENNESS

Regulator Creates balanced regulations

Advocate Promotes startups

Customer Uses open innovation to engage the ecosystem

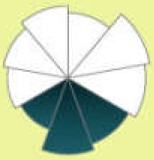


INFRASTRUCTURE

Strategist Has clear support for innovation

Digital governor Low-friction engagement

Datavore The city publishes live, open data with APIs



LEADERSHIP

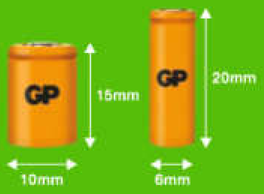
Host Effective use of space and networks

Investor Invests in skills and funding

Connector Access to Wi-Fi, public transport and cycling

ILLUSTRATION: ALAN WALCOCK; VALENTINA D'FELIPPO

small cells
big power



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The future of bionics is in his hands

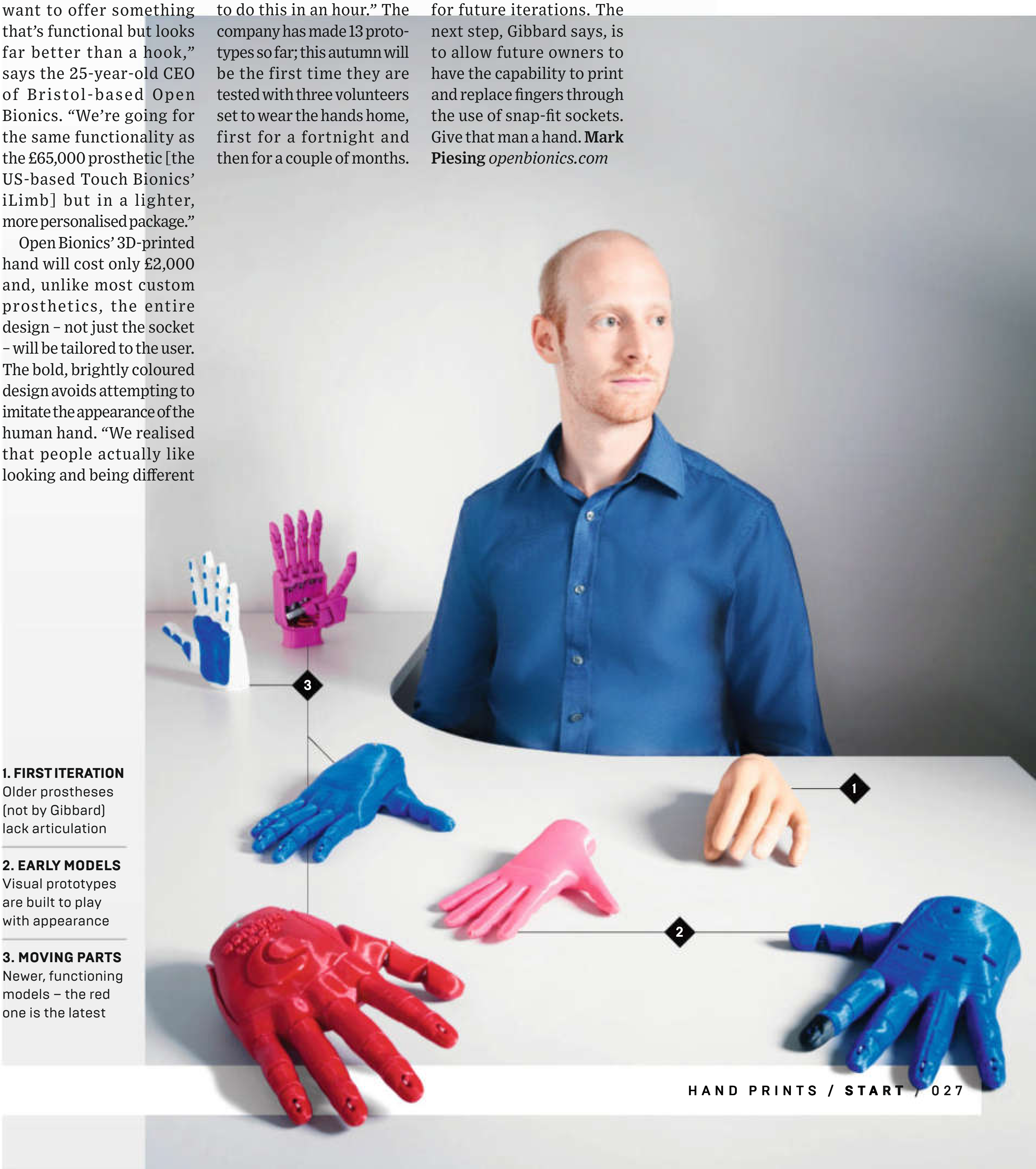
A childhood hobby led Joel Gibbard to design a new type of artificial extremity

WHEN IT COMES TO prosthetic hands, options are limited: a rigid cosmetic attachment; an awkward hook; or a heavy, expensive robotic appendage. Joel Gibbard (*pictured*) believes there's another way. "We want to offer something that's functional but looks far better than a hook," says the 25-year-old CEO of Bristol-based Open Bionics. "We're going for the same functionality as the £65,000 prosthetic [the US-based Touch Bionics' iLimb] but in a lighter, more personalised package."

Open Bionics' 3D-printed hand will cost only £2,000 and, unlike most custom prosthetics, the entire design – not just the socket – will be tailored to the user. The bold, brightly coloured design avoids attempting to imitate the appearance of the human hand. "We realised that people actually like looking and being different now," explains Gibbard, who says his passion for robotics began while playing with LEGO Technic as a child.

Waiting times for a new prosthetic typically run to around a month. Open Bionics can 3D print the custom parts in 40 hours, assemble them in two, and have the entire process, from scan to fitting, completed in less than a week. "The challenge," Gibbard says, "is to do this in an hour." The company has made 13 prototypes so far; this autumn will be the first time they are tested with three volunteers set to wear the hands home, first for a fortnight and then for a couple of months.

Development was funded through a £43,593 Indiegogo campaign – followed by $120,000 (£76,000) from Disney's accelerator programme. Open Bionics plans to start selling the custom-made hands in the second half of 2016, though the designs will remain open source, allowing anyone in the world to not only print their own hand, but also to suggest improvements for future iterations. The next step, Gibbard says, is to allow future owners to have the capability to print and replace fingers through the use of snap-fit sockets. Give that man a hand. **Mark Piesing** *openbionics.com*



1. FIRST ITERATION
Older prostheses (not by Gibbard) lack articulation

2. EARLY MODELS
Visual prototypes are built to play with appearance

3. MOVING PARTS
Newer, functioning models – the red one is the latest

PHOTOGRAPHY: DAN BURN-FORTI

PHOTOGRAPHY: JAMES BALL

To Oxfordshire and beyond

A new, rapid-cooled engine designed in Abingdon is vying to put a European space plane within reach

THIS BIG CLOUD OF STEAM COULD SOON BE THE secret to sending an aircraft into outer space. The work of Oxfordshire-based Reaction Engines, the Synergetic Air-Breathing Rocket Engine, or SABRE, is a new type of rocket engine that would allow a plane to reach orbit in around 15 minutes, release a payload, return to Earth and land on an airstrip. The company's founding director, Alan Bond, explains that conventional liquid hydrogen rockets are too fuel-thirsty – and therefore too heavy – to make a space plane viable. "Rocket engines alone can't quite hack it," he says. That's why SABRE was designed as a hybrid between a rocket and a jet engine. "If you used jets inside the atmosphere to get to around Mach 5 or Mach 6, and then you transitioned to rockets to get into orbit, you'd stand a good chance of making it."

Jetting up to Mach 5 – 1.7kps, or five times the speed of sound – is problematic: at that speed, the air passing through the engine heats up quickly, slowing down propulsion. But traditional cooling systems make the engine heavier and slower. That's where SABRE's main technology, the "precooler", comes in. This spiral of one-millimetre-thick micro-tubes is kept cold by the liquid hydrogen that will later fuel the rockets. "It enables the engine to take in air at 1,000°C and cool it down to -150°C," Bond explains. "This happens in one hundredth of a second." The cloud pictured left is what it looks like when it happens on Earth.

One of SABRE's ultimate uses will be in Skylon, a space plane that caught the eye of the European Space Agency. In 2013, the Agency commissioned a €1 million (£728,000) study that concluded that "the Skylon can be realised given today's technology and successful engine development." To see it in the air, though, we'll have to wait for the Skylon's first test flight in 2019. Watch the skies... **GV** *reactionengines.co.uk*

◂◂

CULHAM, OXON
Reaction Engines tries out its precooler in a cryogenic test at the Culham Science Centre. This cools air by 1,150°C in a fraction of a second, using liquid hydrogen.

◂

WESTCOTT, BUCKS
An engine burns for six seconds during a night test at Airborne Engineering in Westcott. Reaction Engines is exploring how to apply its technologies to power civilian aircraft as well as space planes.

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A TIMELINE OF US MISSIONS TO MARS

by Danielle Venton

× Failed missions

1964	× **Mariner 3**	Fails to eject its protective shield; the added weight throws it off trajectory.
1965	**Mariner 4**	Completes a successful fly-by, returning images and readings of the planet's atmosphere.
1969	**Mariner 6/ Mariner 7**	Complete fly-bys study the surface and atmosphere to see if Mars might host life.
1971	× **Mariner 8**	Fly-by mission fails on launch when the engine and spacecraft separate.
1971	**Mariner 9**	Reaches Mars orbit successfully and is the first craft to orbit another planet.
1993	× **Mars Observer**	Contact is lost with the orbiter three days before it reaches the planet.

MARS OR BUST

There's something about the red planet – so close and yet so far, inhospitable yet perhaps not totally uninhabitable – that keeps us dreaming about getting there one day. Here's what that trajectory might look like, from the fictional world of best-seller *The Martian* (now a recently released film starring Matt Damon) to the technology we still need to crack.

1. Q & A

Andy Weir
Author
of *The Martian*

It opens on a nightmare: an astronaut is left on Mars and must survive on the hostile planet. The author of *The Martian*, Andy Weir, a former software engineer, includes so many technical details in his book – orbital trajectories, the molecular tricks for turning air into water – that you might think a manned mission to Mars would be a cinch. Not so fast, Weir says. We shouldn't get hung up on humans reaching the surface. **David Ferry**

WIRED: In the book, Mars missions have become almost routine. Do you think that we'll send astronauts to Mars anytime soon?
Weir: I suspect that the first manned exploration will actually be sophisticated robots on the surface and humans in orbit.

Why's that?
One of the challenges of unmanned exploration is the robots have to land themselves – Mars is kind of a graveyard for probes. But imagine that they send seven probes into a parking orbit above the planet. Then they send humans. Now we have humans in orbit and in instant communication with the probes. The humans make sure that the probes land correctly.

Then is it even worth sending astronauts to the surface?
Oh yeah. Why did Sir Edmund Hillary climb Everest? [Laughs.] But it's hard to justify the additional costs and risk. Still, I would like to have humanity able to survive if there's a catastrophe on Earth. It's not within our technological reach to colonise Mars right now, despite what some groups say, but we can do it eventually.

Do you think science fiction can influence (or inspire) policy?
Things capture public attention, and if that's a side effect of my book, I'm happy. There's nothing Nasa is going to learn from me – I'm just a space enthusiast. All I have to do is make shit up convincingly enough so you think it's true.

ILLUSTRATION: KYLE HILTON; MASSIMO DALL'OGLIO

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1996
Pathfinder Brings the six-wheeled rover *Sojourner* to Mars.

1998
Mars Global Surveyor Successfully orbits the planet to study its topography and surface composition.

1999
✕ ***Mars Polar Lander*** Loses communication on atmospheric entry and has not been heard from since.

1999
✕ ***Deep Space 2*** Two probes attempt to penetrate the surface and sample Martian soil; contact is lost.

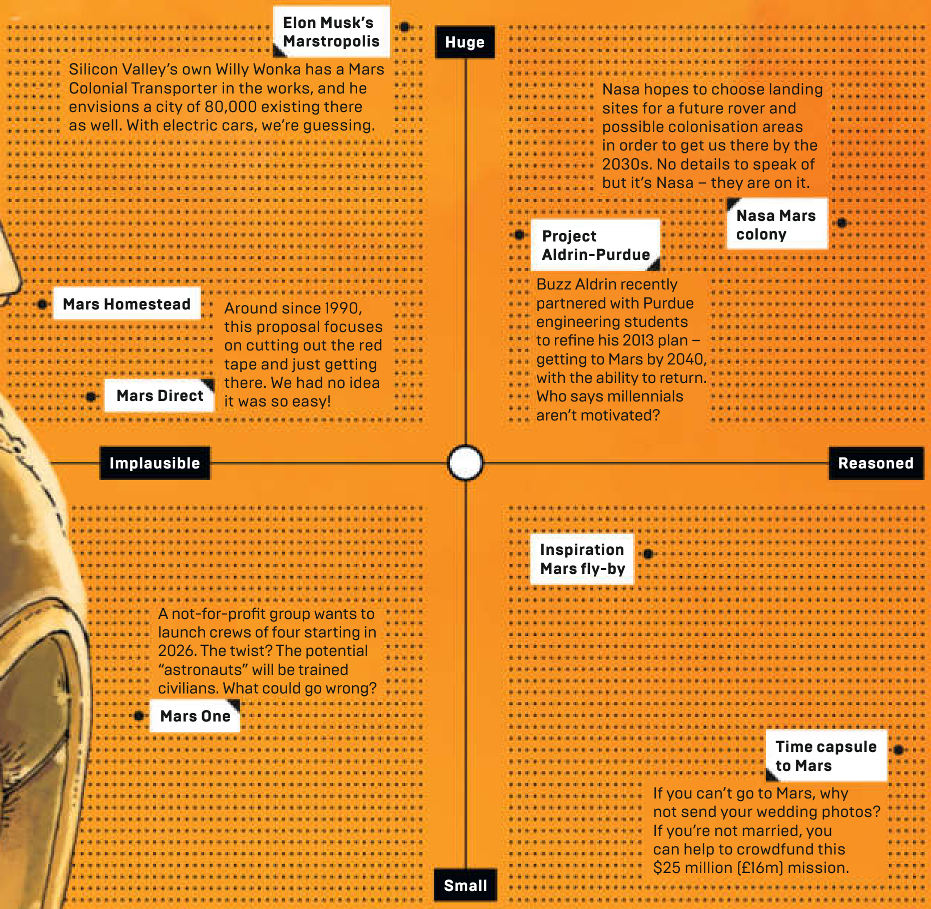
1999
✕ ***Mars Climate Orbiter*** Disappears into the upper Martian atmosphere when it misses its target-altitude orbit.

2001
Mars Odyssey *Orbiter* reaches Mars safely and acts as a communications relay for the rovers *Spirit* and *Opportunity*.

2003
Spirit Mission: to study the atmosphere; characterise rocks and soil, as well as to look for signs of water.

2003
Opportunity Mission: the same as *Spirit*'s.

2. Just because all signs point to Mars's being a barren wasteland doesn't mean that people don't have plenty of ideas of how to get there. Here's an overview. Shara Tonn



Elon Musk's Marstropolis
Silicon Valley's own Willy Wonka has a Mars Colonial Transporter in the works, and he envisions a city of 80,000 existing there as well. With electric cars, we're guessing.

Nasa Mars colony
Nasa hopes to choose landing sites for a future rover and possible colonisation areas in order to get us there by the 2030s. No details to speak of but it's Nasa – they are on it.

Project Aldrin-Purdue
Buzz Aldrin recently partnered with Purdue engineering students to refine his 2013 plan – getting to Mars by 2040, with the ability to return. Who says millennials aren't motivated?

Mars Homestead

Mars Direct
Around since 1990, this proposal focuses on cutting out the red tape and just getting there. We had no idea it was so easy!

Inspiration Mars fly-by

Mars One
A not-for-profit group wants to launch crews of four starting in 2026. The twist? The potential "astronauts" will be trained civilians. What could go wrong?

Time capsule to Mars
If you can't go to Mars, why not send your wedding photos? If you're not married, you can help to crowdfund this $25 million (£16m) mission.

3. Look on the bright side

Life on Mars poses challenges. All you need is an open mind – and to know you're not in Kansas anymore and will not see it again. **Rhett Allain**

Mars is 225 million kilometres from Earth.

Pro	Con
If Earth is hit by a meteor or a deadly epidemic, people on Mars will probably be fine. Humanity will live to destroy yet another planet.	Light – and radio waves – can take from three to 22 minutes to travel from one planet to the other. That's one annoying Skype session.

The surface gravity on Mars is a third of that on Earth.

Pro	Con
Future Martian athletes might grow taller and be able to jump higher with similar effort. Basketball will be fun.	If they have to play an NBA team on Earth, Martians are screwed— competing at full g will be like wearing cement shoes.

Mars's atmosphere is one per cent as thick as Earth's – and is mostly CO_2.

Pro	Con
A low-density atmosphere makes it much easier to launch into orbit from the surface, which could facilitate crucial resupply trips.	Far less protection from cosmic radiation, which could make those resupply trips likely to include a truckload of aluminium foil.

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2005	***Mars Reconnaissance Orbiter***	Studies the Martian climate and surveys sites where future missions could land.
2007	***Phoenix Lander***	Goes to study water history and habitability at the northern latitudes of the red planet.
2011	***Curiosity***	The largest rover yet sent to Mars successfully launches. And it's still going.
2013	***Maven Orbiter***	Goes to study the atmosphere.
2020	**Nasa**	The agency plans to send a successor to *Curiosity.*
2021	**Inspiration Mars**	A private venture plans to slingshot around Mars and Venus to demonstrate its technology.
2026	**SpaceX**	A crewed mission will launch and begin establishing a Martian base. Supposedly.
2030	**Nasa**	Has vague plans to send humans to Mars.

4. How we'll colonise the red planet

Earthlings have held much of the technology to become Martians for more than 30 years, according to Stephen Petranek, author of *How We'll Live on Mars*. It's the willpower and drive that are missing. Now that private efforts, such as Elon Musk's SpaceX, are providing some of that drive, here are the challenges they'll face. DV

i

Unlock the water
There is plenty of frozen water on Mars in the form of glaciers and polar caps. Plus, the soil is up to 60 per cent H_2O. But we'll have to unlock it somehow. If that fails, University of Washington researchers have a plan B: a device called the Water Vapor Adsorption Reactor – an industrial-level dehumidifier – that could extract water from the atmosphere.

ii

Make some air
That water is going to be important, because we'll need it to make oxygen. (You probably remember this from school but just in case: stick two electrodes in a tank of water and turn on the power. Oxygen collects on the positive side and hydrogen on the negative.) When Nasa launches the heir to *Curiosity* in 2020, the agency will test a device that uses a similar process to split oxygen atoms off the CO_2 molecules in the Martian atmosphere.

iii

Turn up the heat
Terraforming! First, raise the temperature, perhaps with vast sunlight-reflecting mirrors. Frozen gases will be released, forming a denser atmosphere and causing a greenhouse effect. Water will flow. Plants will grow, releasing O_2. If life once existed on Mars, maybe it can do so again.

5. What it would be like

Martha Lenio, mission commander of the HI-SEAS III Mars simulation programme, tells us what we're up against.

For a three-year mission with a spaceship, you have to figure out which spare parts you need, how to fix things when you're far away from Earth and how to deal with waste. I have no hesitation about having enough solar-powered batteries and hydrogen. I can see us recycling water and composting waste. I'm confident we can do missions where we come back to Earth or are resupplied, but I can't see a way for us to live sustainably on Mars. We haven't figured out how to live sustainably on Earth yet – and Mars is very harsh. **As told to Shara Tonn**

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FLY, SQUID BOT, FLY

Mirko Kovac makes nature-inspired drones that can walk, swim and perch

MIRKO KOVAC WANTS to create bio-inspired flying drones to do our dirty work for us. As director of the Aerial Robotics Laboratory at Imperial College London, he has built micro-bots inspired by locusts, butterflies and grasshoppers to work in places that are inaccessible or dangerous, such as underwater oil pipelines or remote wind turbines.

"Drones perform better working together in a system than in isolation, and need a systems-level approach to their design," says Kovac. His big idea: borrow from nature. "Nature has some of the same design requirements as us, such as weight and energy use. But rather than blindly copying nature, we need to be inspired by it."

By studying the principles behind a perching bird, Kovac has developed a drone the size of a pigeon that can perch by flying straight into the side of a building. The mechanical forces from the impact trigger its two arms to fly forward and make a snapping motion that grabs on to the brickwork without the expenditure of any additional energy.

Kovac's next move is to adapt the principle of multi-modal mobility – the ability to move between water, land and sky. He is currently working on building novel classes of robots that can effortlessly switch between swimming, walking and flying. First prototypes of a propulsion unit for such multi-modal robots are between 4cm and 45cm in size and use highly pressurised CO$_2$ to propel an equally sized drone into the air. A 70g vehicle reached speeds of 11mps in just under a third of a second, and preliminary work has shown that jumps propelled from under the water's surface could have a range of up to 20m. Sometimes, it's the small things that change the world. **Mark Piesing** *imperial.ac.uk/aerialrobotics*

Below: Mirko Kovac with one of Aerial Robotics Laboratory's gliding drones

PHOTOGRAPHY: MARK NIXON

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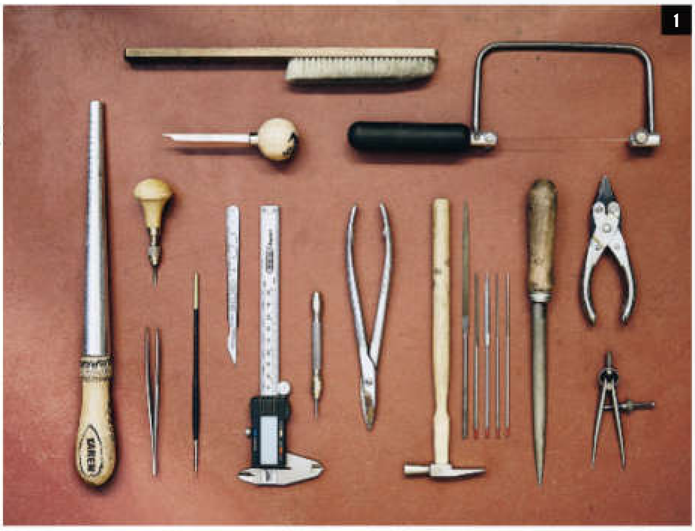
A desk for £10m skulls – and catching spare gold dust

Our series on tools for trades visits a Mayfair jewellery workshop where precious is the norm

BENTLEY & SKINNER'S CENTRAL London jewellery workshop is a lesson in accuracy. Three goldsmiths wearing 10x magnification goggles sift through a rack of small tools. "We adapt many of the tools ourselves, depending on what we need. For instance, when you bend these pliers to a certain angle, you get a very different function," explains master goldsmith Karen Avakian. He is converting two Victorian silver brooches into earrings.

Founded in 1881 as Skinner & Co, the firm has earned a reputation as a centre for goldsmithing innovation. "We take commissions to make jewels and other objects," says B&S jeweller Ilias Kapsalis. "We manufactured Damien Hirst's skull [*For The Love of God*, 2007]." To make the piece – a platinum skull encrusted with human teeth and 8,601 diamonds – Avakian says he had to use a laser welding machine, because a regular solderer would not have provided great enough precision. A second-generation goldsmith, he explains that the laser is one of the few pieces of modern tech in the whole workroom. "In general, this workshop looks pretty much the way it would have looked 50 or 100 years ago: same tools, same methods," he says. **Gian Volpicelli** *bentley-skinner.co.uk*



1

TOOLKIT

2

3

1
TOOLS
Goldsmithing tools resemble surgical instruments – and share the need to achieve high levels of precision. "Once, I made a silver mermaid smaller than my thumbnail," Avakian says. "Etching the nipples was excruciating." Whether the purpose is gauging, dividing or polishing, each utensil has to couple strength with gentleness, to avoid breaking or deforming the delicate pieces. The iron head of the tiny hammer is coated in rubber. Another mallet's head is made from rolled pig skin: it is used with the graduated iron rod to beat rings into shape. "It's not soft, but it's light enough not to damage the jewel," Avakian explains.

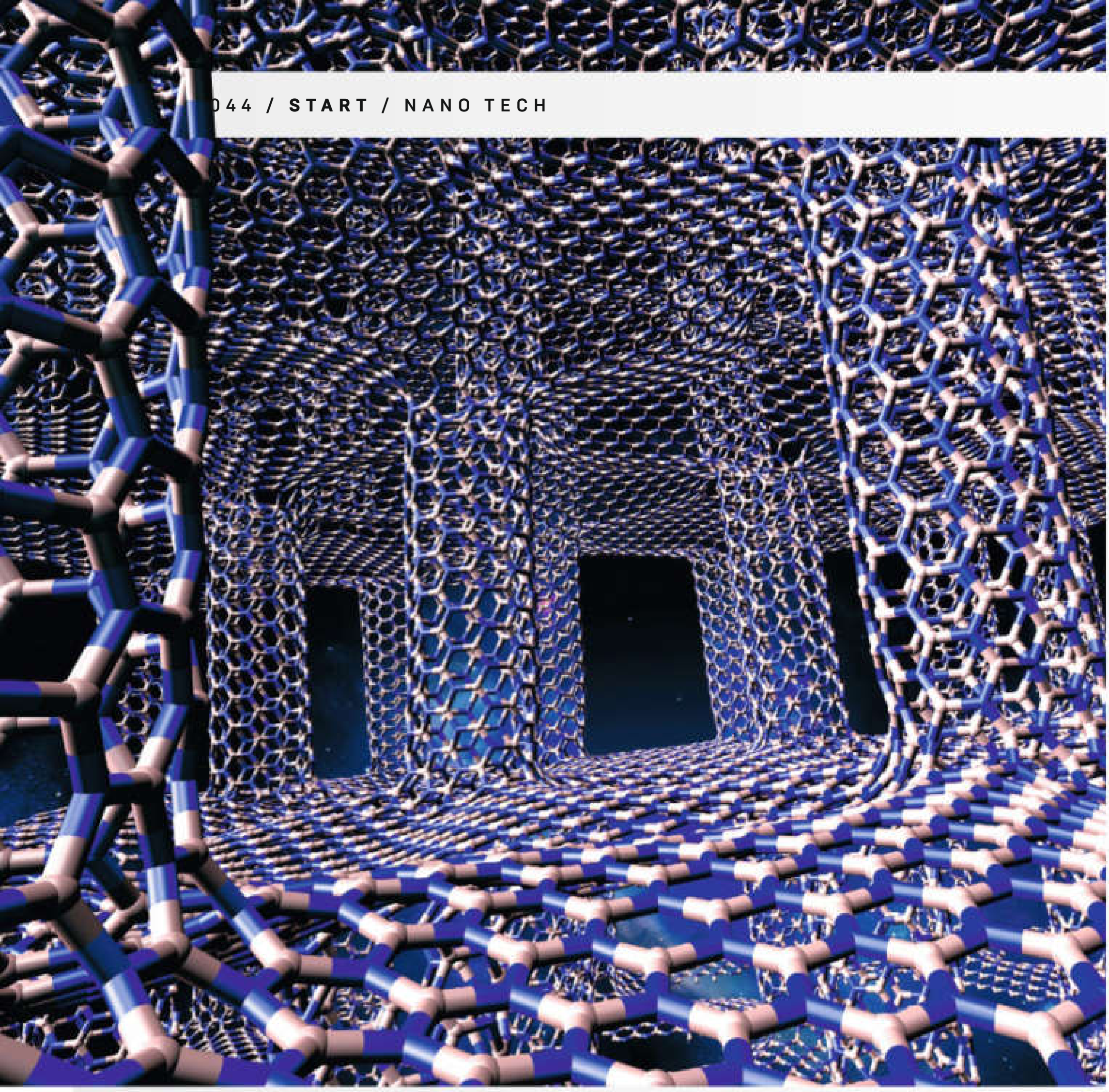
2
LASER WELDING MACHINE
This machine is used to unite tiny components, and fill dents on the surface of a piece of jewellery with quickly molten gold or silver. "You add some gold wire on top of the jewel, and it'll zap and solder them instantly," says Avakian. The beam of this machine can be narrowed down to a diameter of 0.2 millimetres.

3
MILL
These mills are used to transform molten metal – or leftover scraps of solid gold and silver – into wire, which makes it easier to work with. "The mills are the first step in a long process," Avakian says. "Once you get the wire, you pass it through dies to give it a certain shape, or you use a vice to curl it into a ring."

4
GOLDSMITH'S TABLE
The workbench is crammed with hundreds of instruments, including pairs of pliers and jars of acid for cleaning gold objects blackened by soldering flames. The Plasticine and wax stuck to the table's edge are used to make replicas of gems to be mounted on pieces of jewellery. "It's to understand the dimensions and make a collet [the socket where a stone is lodged] of the right size," explains Avakian.

Gold dust and trimmings fall into this apron – up to four grams a day

PHOTOGRAPHY: SUN LEE



Graphene gets cool

A Texan team wants atom-thick heat dissipators to replace your laptop fan

A MICROSCOPIC colonnade like this could soon replace your laptop's energy-guzzling fan. Researchers at Rice University in Texas simulated how heat would flow through this 100-nanometre 3D structure of boron nitride, also known as white graphene, and discovered that it could be used to cool devices. The reason? The single-atom-thick substance diffuses heat quickly across two-dimensional sheets.

The challenge has been to move the heat vertically, explains lead researcher Rouzbeh Shahsavari. "If you want to send the heat outside a plane to channel it from one layer to another, these materials aren't good," he says. "When you stack sheets of boron nitride, they behave as if they aren't connected."

Shahsavari's idea was to link the sheets with tubes of the same material. He discovered that heat would move horizontally as well as vertically between planes. Also, by changing the length of the tubes and the space between them, it is possible to fine-tune how heat moves across the structure. Such nanostructures could be useful in electronics, at a time when ever-shrinking devices are making heat management a major problem. "At that scale, if the system becomes too hot, it might quickly degrade the properties and the lifetime of the device," Shahsavari says.

Manufacturing a one-atom structure is expensive, but Shahsavari remains optimistic about the technology's potential. "They could end up in your computer or your iPhone." **Gian Volpicelli**

EARLY ADOPTERS

WHAT'S EXCITING...

ALICE TAYLOR

CEO, MakieLab

"As someone who works on the crossover between toys and video games, I'm hugely excited by **Disney's Playmation**: physical toys that require running, jumping and energy expenditure powered by wearables. Room to play is shrinking, so toy-game hybrids like this (and imagine the future expansions) will make a big difference."

WHAT'S EXCITING...

DAVID ORBAN

Founder, Network Society Research; adviser, Singularity University

"The **Dangerous Things** NFC implant allows me to explore the edges of user interaction, computer interfaces, social reactions to radical transparency, and to start conversations about cyborgification. It's only version 1.0, so it's clunky and unregulated, but it's as full of promise as the start of the PC revolution."

WHAT'S EXCITING...

EDWARD MILLER

Co-founder, Medical Realities

"**AltSpaceVR** is incredible. It's a platform that allows you to put on a pair of virtual-reality goggles (like the Oculus Rift) and be anywhere, with anybody, in virtual reality. It's a little like *The Sims* but you're connecting with real people around the world. It's on another level, and it's making the web more human." **GV**

BVLGARI

BVLGARI
MAN
IN BLACK

HOW WILL TECHNOLOGY ENHANCE OUR BODIES IN THE NEXT DECADE?

THE BIG QUESTION

MARTINE ROTHBLATT

CEO, UNITED THERAPEUTICS

"Technology will enable an increasing number of cancers to be defeated by biochemically adjusting the body's immune system to quash cancerous cells. Other technologies will increase the number of transplantable vital organs, either by restoring more from cadaveric donors to acceptable condition, or as a result of organ-manufacturing processes based on regenerative medicine. Also, ultra-cheap personalised gene-sequencing technology and bioinformatics will enable many diseases to be recognised and muted while symptoms are still sub-clinical, resulting in greater human longevity." **Gian Volpicelli**

ILLUSTRATION: PAUL RYDING

HANS JØRGEN WIBERG

FOUNDER, BE MY EYES

"Our non-exponential body is about to be surprised. Thanks to cochlear implants, we are now seeing the last generation of deaf people. Bionic eye implants and stem-cell treatment will dramatically reduce blindness. Also, why shouldn't hearing aids monitor temperature and pulse and play music? Why shouldn't a paralysed person with an exoskeleton be the strongest guy in town, or bionic eyes have night vision?"

JENNIFER FRENCH

EXECUTIVE DIRECTOR, NEUROTECH NETWORK

"Technology will provide more accurate and thorough diagnosis of medical conditions of both body and mind. New brain-activity recording techniques could be leveraged to create an integrated human experience wherein the tech element would become less and less visible, with improved performances.
The challenge is whether our societal infrastructures can keep pace with the advancements and human demand."

FARIDA BEDWEI

SOFTWARE ENGINEER; AUTHOR, *DEFINITION OF A MIRACLE*

"Using advanced algorithms and AI theories, we'll be able to make headway in curing neurological conditions such as cerebral palsy, Parkinson's and motor neurone disease. We should also be able to build a model of how the brain's neurons react to certain scenarios and feed that information back to the patients. I also envisage 'smart' sensor-aided walking aids and wheelchairs."

LARRY JASINSKI

CEO, REWALK ROBOTICS

"The combination of the human body and robotics will expand, with more software applications, sensing capabilities and improved battery technologies. By 2025, exoskeletons will enable stroke victims and multiple sclerosis sufferers to walk again. They will also help to remove the limitations that occur with age. The capacity to expand exoskeletons to run faster and jump higher may become part of daily life."

LEONARD GUARENTE

CO-FOUNDER, ELYSIUM HEALTH

"A convergence of science-based interventions will ensure people remain healthier longer. Prescription medicines will be developed to target proteins, such as sirtuins and mTOR, that regulate ageing. Stem cells will allow the rejuvenation of degenerating tissues. Imaging advances will lead to earlier detection of cancers and Alzheimer's.
And device-driven self-monitoring will spur healthy living."

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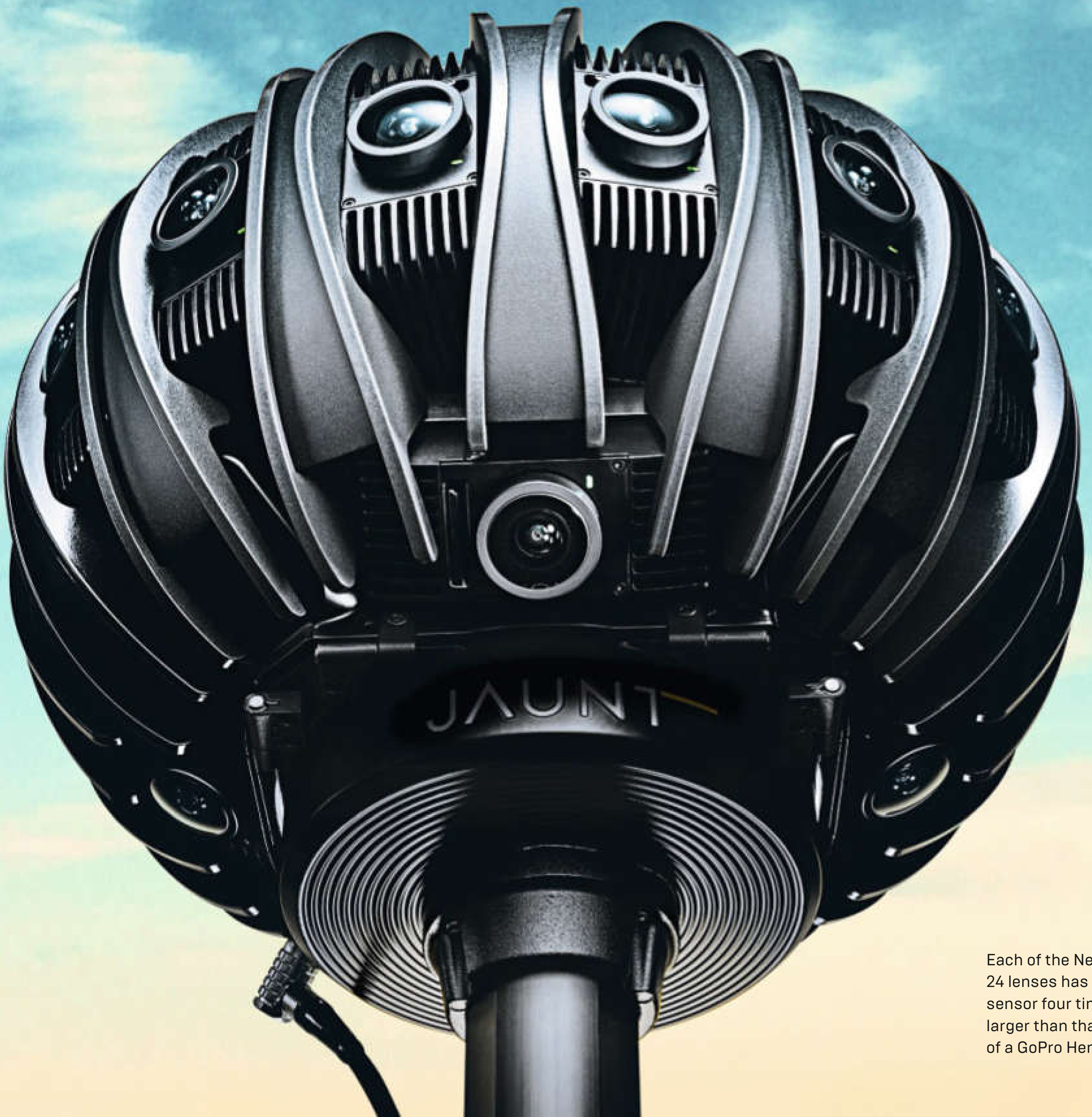
TECHNOGYM
The Wellness Company

EYES ON THE FUTURE: HOLLYWOOD'S 360-DEGREE VISION

We may still be in the pre-dawn hours of the virtual-reality age – consumer headsets from Oculus, Sony and HTC are coming within months. But after more than two years in development, the Jaunt Neo camera is here to help film-makers create the virtual movies of their non-virtual dreams. Until now, capturing 360° 3D video has meant rigging together an array of GoPro or Red cameras; the Neo packs 24 custom-built lenses. More importantly, it does away with the painstaking post-production that bogs down most VR shoots. Synchronised cameras and Jaunt's algorithm allow for an all-encompassing image with no visible stitching. Don't bother getting out your credit card, though. The company is making the Neo available only to its "creative partners" – which, once contracts dry, means some of Hollywood's top directors. It's clear that the revolution won't just be televised. It'll be fully immersive. **Peter Rubin** *jauntvr.com*



Each of the Neo's 24 lenses has a sensor four times larger than that of a GoPro Hero4

PHOTOGRAPHY: JOSEPH SHIN

oppo

PM-3
Closed-back Planar Magnetic Headphones

Now available
in red and blue

tech radar 2015 EDITOR'S CHOICE ★★★★★

“Don't even bother reading this review - just go out and buy these headphones”

avforums RECOMMENDED AWARD

“...this is a superbly built, exceptionally comfortable and immensely talented headphone”

Trusted Reviews EDITOR'S CHOICE

“10/10”

“The OPPO PM-3 are some of the best portable headphones ever made”

SOUND & VISION

“Simply put, the OPPO PM-3 are my favourite closed-backed headphones currently available”

oppodigital.co.uk

GoPro
Be a HERO.

LAKEY PETERSON
Photo by: Lakey Peterson

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NEW
HERO4
CAMERAS

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Adbuster

Till Faida's Adblock Plus was popping up long before iOS 9

AD-BLOCKERS JUMPED TO THE TOP of the App Store when Apple allowed them in September – but Till Faida had already been obliterating ads for years. "Most of our users are not against ads," says the CEO of Eyeo, the German startup behind the Adblock Plus extension. "They are just annoyed by the banners, overlays, pop-ups and so on."

The problem: with around 198m active ad blocker users worldwide – according to a report this August by ad-blocker-tracking startup PageFair – the cost to the publishing industry is estimated to reach $22bn (£13.9bn) this year.

Launched in 2011, Acceptable Ads, a whitelist of more than 1,000 publishers, including Google and Amazon, was Eyeo's attempt to address this, allowing ads that passed the team's manual review process. "About ten per cent of the publishers on the whitelist pay us," says Faida (*pictured*). "By charging these large companies, we can provide it for free to the other 90 per cent."

Not everyone is a supporter. In May 2015, the company defeated the fourth court action brought by publishers – this time by German broadcasters RTL and ProSiebenSat1 – arguing that the whitelist is anti-competitive.

AdBlock Plus continues to expand regardless. Yet won't Apple's new iOS 9 tools make it redundant? "The Apple update will just offer an API to companies like us, which is great news," laughs Faida. "It will make it a lot easier for us." MV *eyeo.com*

PHOTOGRAPHY: KATRIN BINNER

WIRED	TIRED	EXPIRED
Loon Sri Lanka	**Guerrilla mesh networks**	Civic open Wi-Fi
OS-level ad blocking	HoloLens IRL ad blocking	**Ghostery**
iCloud Voicemail	**Google Voice**	Actually conversing
Ethereum	Fidelitycoin	**ASCII *Star Wars***
Xiaoice	**Hal**	SpaceX

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'A knife-sharp thriller' Daily Mail
'Unbearably gripping and suspenseful' Sophie Hannah
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HarperCollins sponsored Ocean's Wi-Fi network at the Eat Street @ Westfield London screen to offer readers a downloadable extract of the Sunday Times bestseller 'The Ice Twins'.

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Find out more at
oceanoutdoor.com/harpercollins

TEAM GB
OFFICIAL MEDIA PROVIDER

OCEAN

APPS OF THE MONTH

BEAKER

WIRED

By turning your iPhone into a virtual beaker, this app lets you simulate reactions with more than 150 chemicals. Shake it, heat it, even pour in chemical mixes from other *BEAKER*-equipped devices. *iOS, 79p thixlab.com*

PRUNE

Describing itself as "a love letter to trees", *Prune*'s beautifully minimalistic design is matched with elegantly simple gameplay in which you swipe your finger to help a virtual tree grow into the sunlight. *iOS, £2.99 prunegame.com*

GENIUS

Dive into the meaning behind the music with *Genius*'s new app for Android, which allows you to access crowdsourced lyrics annotations for more than 1.7 million songs on the go. *Android, iOS, free genius.com*

MEISTERTASK

Collaborate Kanban-style with this task app from the creators of mind-mapping tool *Mindmeister*. Share checklists, attachments and progress updates across unlimited projects. *iOS, free meistertask.com*

THE EVERYTHING MACHINE

Designed for kids but fun for adults too, this app lets you combine your device's hardware elements to build creative machines, from a stop-motion camera to a kaleidoscope. *iOS, £2.49 tinybop.com*

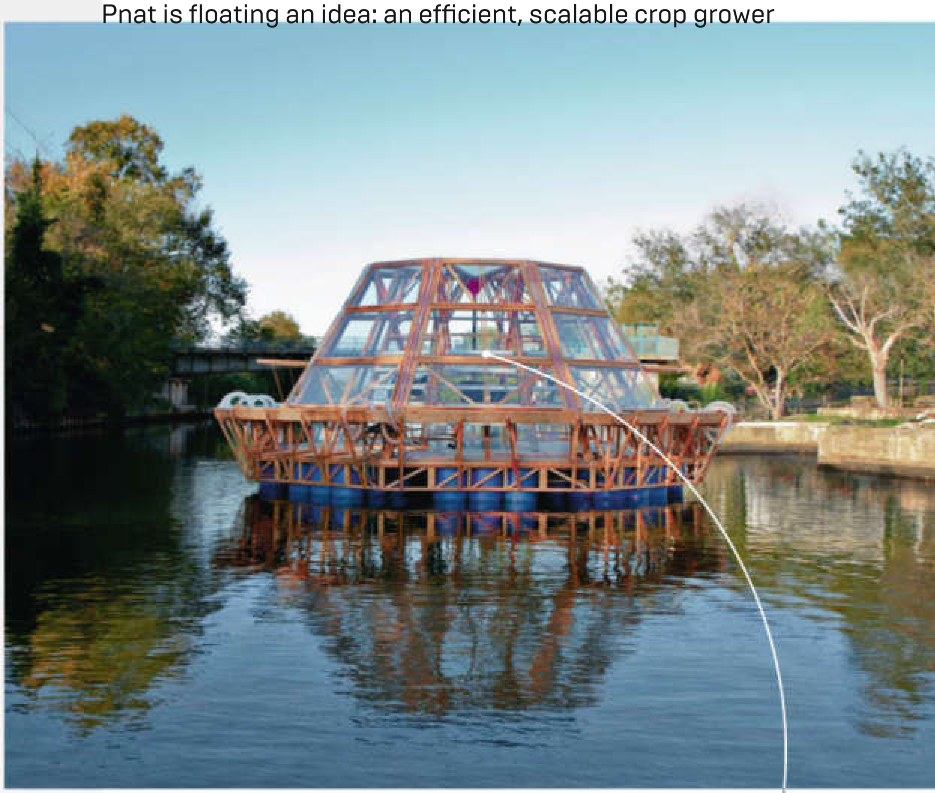
DON'T STARVE

WEIRD

In this remake, the player takes on the role of Wilson, "an intrepid gentleman scientist" trapped in a strange wilderness. Learn how to exploit its resources and inhabitants to survive. *iOS, £3.99 kleientertainment.com* **KN**

The greener house

Pnat is floating an idea: an efficient, scalable crop grower



Above: Pnat co-founder Elisa Azzarello tends to the Jellyfish Barge, which floats on a base of recycled plastic drums

THIS TRANSLUCENT STRUCTURE IS A floating farm. Designed by Italian startup Pnat, the Jellyfish Barge aims to alleviate food shortages by growing crops hydroponically, powered by solar energy. Currently on trial in Pisa, the Jellyfish Barge is scheduled to be launched on a canal in Milan and plans are in place to install a €2 million (£1.5m) one-hectare version in either Qatar or Dubai by 2018. "There's not enough fresh water or arable land in these countries," says Camilla Pandolfi, agronomist and co-founder of Pnat. "They rely on imports for more than 70 per cent of fresh food. For food security you need systems that are able to produce food locally."

The greenhouse uses seven solar desalination units to filter 150 litres of water per day in a system designed by environmental scientist Paolo Franceschetti. Crops are grown using just water and nutrients; Pnat claims the prototype's hydroponic cultivation method will provide up to 70 per cent of water savings compared to traditional hydroponic systems.

A single Jellyfish Barge unit measures roughly 70 square metres – around 120 units can be assembled on to a hectare-sized platform. Pnat plans to industrialise production and switch from a wooden base to an aluminium one, which would require less maintenance. The startup is also developing a network of sensors for plants to monitor environmental parameters. Pnat hopes to sell its floating farms for an expected retail price of €10,000 which, according to fellow Pnat co-founder Elisa Azzarello, "is comparable with hydroponic greenhouses". We expect high growth. **Clare Dowdy** *pnat.net*

PHOTOGRAPHY: MATTEO DE MAYDA

THE CARBON CONUNDRUM

EVERYDAY LIFE RUNS ON ENERGY. BUT MUCH OF THIS ENERGY PRODUCES CO_2 EMISSIONS. SO, WHAT IF WE COULD HELP TO STOP CO_2 FROM EVER REACHING THE ATMOSPHERE? THAT'S EXACTLY WHAT SOME PROJECTS AROUND THE WORLD ARE TRYING TO DO USING A PROVEN TECHNOLOGY

Banff National Park in the Canadian Rockies, Alberta

PHOTOGRAPHY: CORBIS

If you think about your everyday life – the smartphone you use, the machine that brews your coffee, and the bus, train or car that takes you to and from the office – it's all powered by energy. As the number of people on the planet increases, so will the desire for goods and services – and the need for energy. Meeting growing energy demand while limiting CO_2 emissions is a global challenge for both society and business.

"We have long recognised both the importance of the climate challenge and the critical role energy has in enabling a quality of life that people deserve, wherever they live," says Tim Bertels, Shell's head of CCS (about which more later). "By 2050, our world could be home to 9 billion people – that's almost two billion more than today. All energy sources will be needed to meet that demand while addressing environmental stresses."

So what's the answer? One option is using a technology called carbon capture and storage (CCS). This is a method of capturing CO_2 emissions from energy production and industrial processing sites, such as power stations, and putting it deep underground again. After all, that's where hydrocarbons – oil and natural gas – were for millions of years before they were extracted.

"The availability and reliability of hydrocarbons are important factors to help ensure that everyone has access to energy, and they can be used to complement the increasing proportion of renewables in the mix. To address the challenge of increasing energy supply – but reducing CO_2 emissions – it is essential to make hydrocarbons cleaner. CCS helps achieve this," says Bertels.

Several respected international bodies agree that CCS is a highly desirable development in energy production. The International Panel on Climate Change estimates that without CCS the cost of limiting the global temperature rise to 2°C would be around 138 per cent higher. The International Energy Agency (IEA; an autonomous intergovernmental organisation founded in 1974) estimates that CCS could deliver about a fifth of necessary worldwide reductions in greenhouse gases by 2050 and a half by 2100.

Bertels sees the environmental and financial savings: "The scale of potential future deployment of CCS is enormous, spanning manufacturing, power-generation capture, transport and storage developments worldwide." The IEA estimates the costs of achieving global climate objectives without CCS to be over 40 per cent higher. The Energy Technologies Institute found that without CCS the additional costs needed just to run a decarbonised UK economy in 2050 would be £32 billion per annum.

CCS is already in action at Shell's Quest CCS project, at the Scotford Upgrader north-east of Edmonton, Alberta. The Scotford Upgrader processes bitumen produced from the oil sands in northern Alberta. With Quest, CO_2 is captured from the upgrading process and stored underground more than two kilometres below the Earth's surface. The Quest project will capture and store about a million tonnes of CO_2 each year, equivalent to taking 250,000 European cars off the road. The Quest project has benefited from CAN $865 million of investment from the Canadian and Alberta governments.

Similarly, the proposed Shell and SSE CCS project at Peterhead Power Station, near Aberdeen in Scotland, could result in the capture of 10-15 million tonnes of carbon dioxide emissions over the project's lifetime. The emissions would be transported by pipeline offshore for long-term storage deep under the North Sea.

QUEST WILL CAPTURE ABOUT A MILLION TONNES OF CO_2 PER YEAR, EQUIVALENT TO TAKING 250,000 CARS OFF THE ROAD

The Quest Carbon Capture and Storage project in Alberta, Canada (*above and below*)

Shell will share the learnings from its CCS projects to help enable more CCS projects to be developed. So how does carbon capture and storage work?

There are three types of carbon-capture techniques in operation around the world. These include pre-combustion, post-combustion and oxyfuel combustion (*see right*). Once captured, the CO_2 is condensed into a liquid and transported via pipeline or truck to the chosen storage side.

When stored in a reservoir after being captured from an industrial plant, CO_2 would be held in place by an impermeable cap rock. This type of rock held the natural gas securely in the reservoir for millions of years. The pressure is kept within safe limits to ensure that the reservoir and its cap are never damaged.

Shell will play its role in providing those solutions to bring more energy and less CO_2 – especially in areas where we have, and can develop, skills such as natural-gas production, future fuels, such as biofuels and hydrogen, and CCS. Shell will do it because we know that our long-term viability as a company depends on our ability to anticipate the types of energy that people will need in the future, in a way that is both commercially competitive and environmentally relevant.

CCS is projected to be a critical tool in the quest to power the planet and enable human progress. It gives us the best of both worlds, which is important because we are not lucky enough to have two worlds.

HOW CCS WORKS

There are three opportunities to capture carbon-dioxide emissions before they can reach the atmosphere

PRE-COMBUSTION

•

Upgrading a barrel of crude oil includes adding hydrogen. Making that hydrogen is one of the primary causes of high CO_2 emissions in the oil upgrading process. This is the first opportunity that CCS presents: pre-combustion. This is when CO_2 is removed at the point of making hydrogen – before the combustion of the fossil fuel.

POST-COMBUSTION

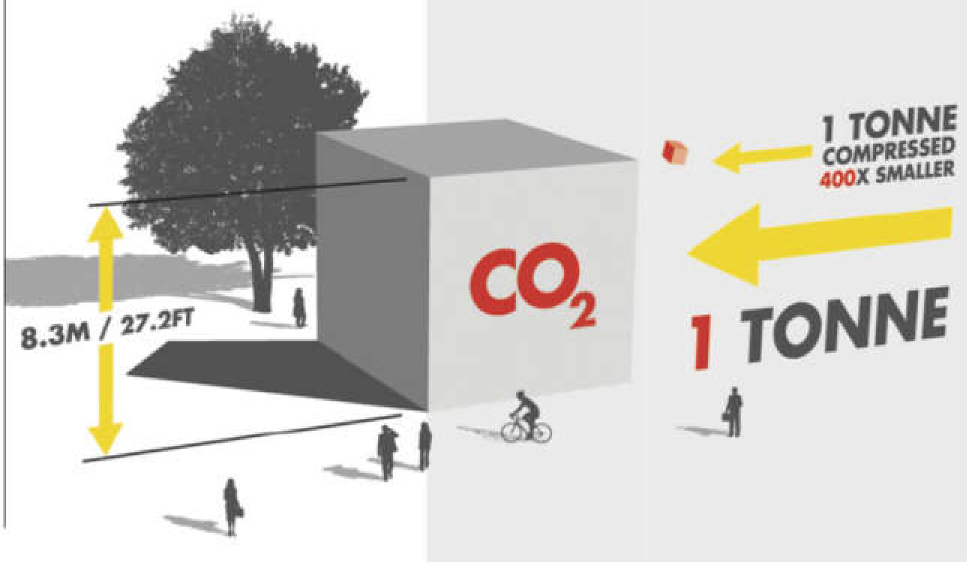
•

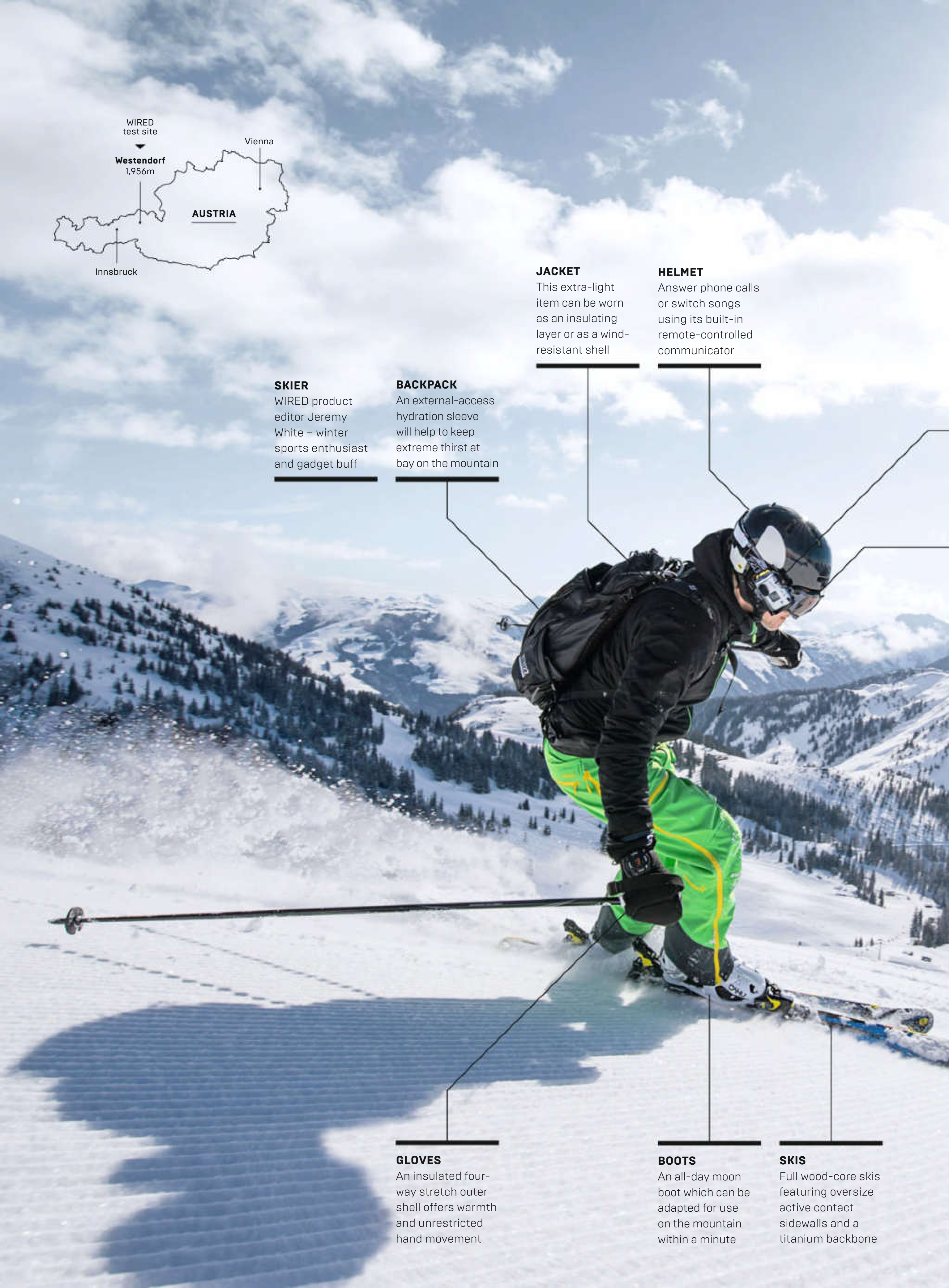
After the oil is upgraded it is transported and used for a range of different products and applications. One of these is generating electricity, which involves burning the oil and releasing CO_2 emissions. This is the second opportunity to use CCS – post-combustion. Here it is captured after the combustion of the fuel, but before emission.

OXYFUEL COMBUSTION

•

In the case of oxyfuel combustion, pure oxygen (O_2) is used rather than air when the fuel is combusted. This produces exhaust gas that is mainly water vapour and CO_2 that can be easily separated to produce a high purity CO_2 stream. This can then be piped underground to a secure storage site.





SKIER
WIRED product editor Jeremy White – winter sports enthusiast and gadget buff

BACKPACK
An external-access hydration sleeve will help to keep extreme thirst at bay on the mountain

JACKET
This extra-light item can be worn as an insulating layer or as a wind-resistant shell

HELMET
Answer phone calls or switch songs using its built-in remote-controlled communicator

GLOVES
An insulated four-way stretch outer shell offers warmth and unrestricted hand movement

BOOTS
An all-day moon boot which can be adapted for use on the mountain within a minute

SKIS
Full wood-core skis featuring oversize active contact sidewalls and a titanium backbone

GEAR

WIRED SNOW SPECIAL GEAR 2015

WIRED DECAMPED TO SKIWELT WILDER KAISER-BRIXENTAL IN WESTENDORF, AUSTRIA, TO ASSESS THE LATEST ESSENTIALS FOR TAMING THE PEAKS

BY JEREMY WHITE AND HENRY FARRAR-HOCKLEY

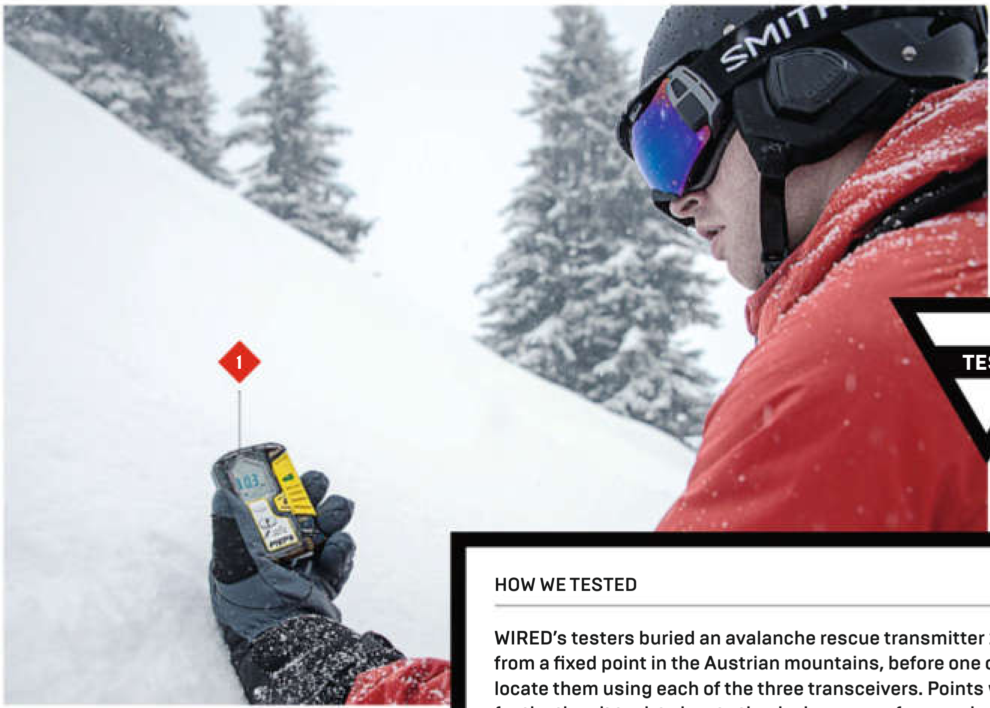
VIDEO CAMERA Equipped with a Tessar lens boasting a 170° field of view

GOGGLES A Bluetooth-enabled HUD can display live data and text messages

PHOTOGRAPHY: CHRISTOPH OBERSCHNEIDER. BADGE ILLUSTRATION: NEIGHBOURHOOD STUDIO

Finders keepers

Which of these avalanche transceivers is worth rescuing?



TEST

HOW WE TESTED

WIRED's testers buried an avalanche rescue transmitter 25 metres from a fixed point in the Austrian mountains, before one of us set out to locate them using each of the three transceivers. Points were given for the time it took to locate the device, ease of use and extra features.

1. PIEPS DSP PRO

The DSP PRO is simple to use, with a lockable catch for switching between modes. The digital display uses a compass arrow to track down buried rescue beacons. This had the longest search range on test, but also took the longest to locate its target. **6/10** *£298 pieps.com*

Search time 1 min 31 secs
Range 60m
Battery life (send) 400 hrs
Features Three antennas

2. BCA TRACKER3

With only a basic readout, this three-antenna transceiver is nonetheless the slimmest of its kind. However, it didn't fare as well on battery life – or range – as its competitors, nor was it the fastest at tracking down the hidden beacon. **5/10** *£289 backcountry access.com*

Search time 1 min 17 secs
Range: 50m
Battery life (send) 250 hrs
Features Multiple burial indicator

3. ORTOVOX 3+

This compact transceiver uses audible beeps and a numerical readout to display the whereabouts of errant alpinists. It required just 34 seconds to find the buried beacon. **8/10** *£250 ortovox.com*

Search time 34 secs
Range 40m
Battery life (send) 250 hrs
Features Recco reflector

SAFETY

HARDWARE

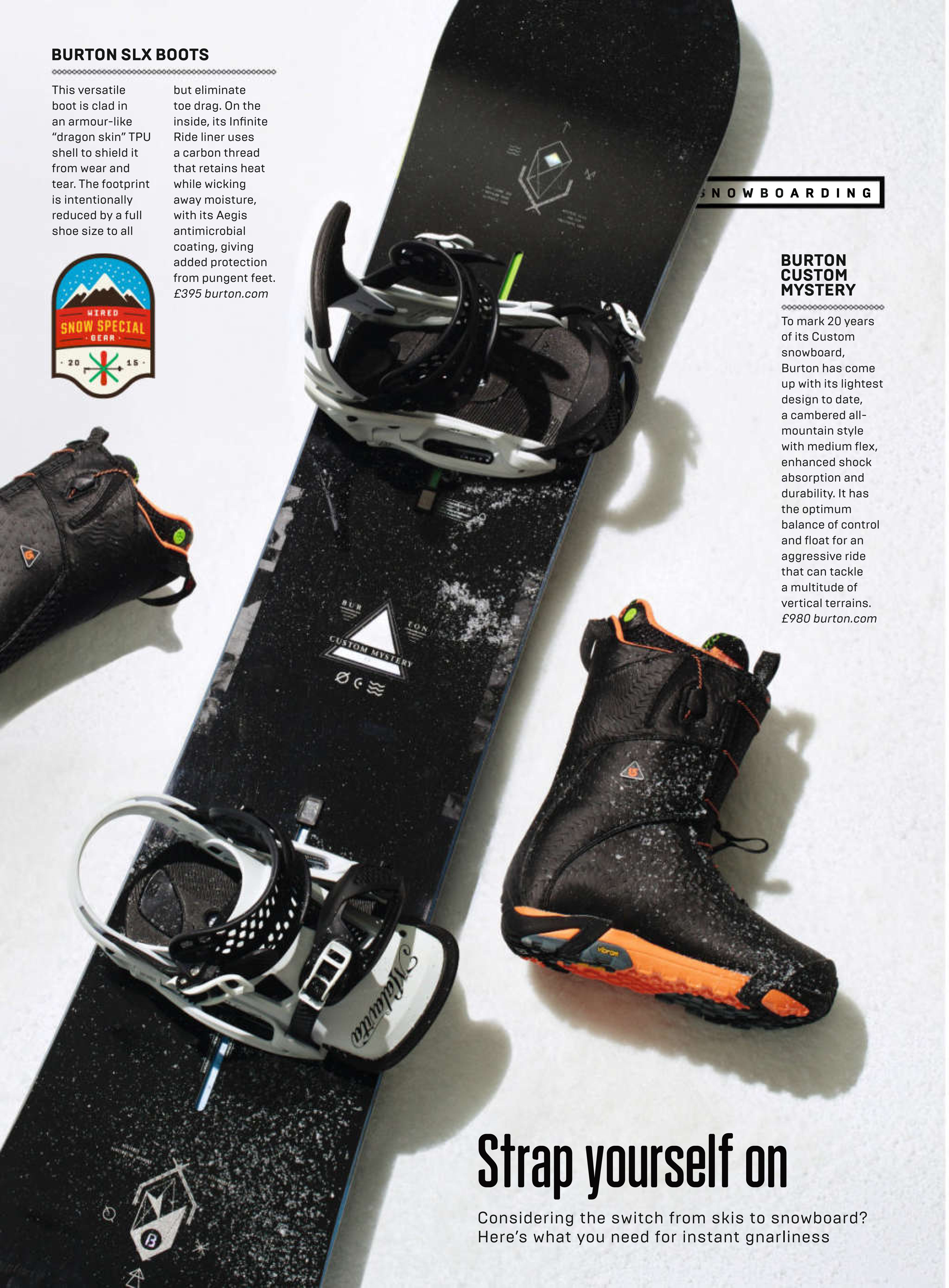
TECH

The SLX's light Vibram XWing outsole is made from 50 per cent recycled materials

BURTON MALAVITA EST BINDINGS

Built for freestyle snowboarding, the Malavita binding's carbon-fibre and composite nylon baseplate evenly distributes the rider's energy for improved flex. Its buckles improve overall strength for a secure fit and the high-backed, canted hinge lets you easily adjust forward lean and rotation separately. *£235 burton.com*

PHOTOGRAPHY: SUN LEE; CHRISTOPH OBERSCHNEIDER; DAVE LIDWELL



Strap yourself on

Considering the switch from skis to snowboard? Here's what you need for instant gnarliness

BURTON SLX BOOTS

This versatile boot is clad in an armour-like "dragon skin" TPU shell to shield it from wear and tear. The footprint is intentionally reduced by a full shoe size to all but eliminate toe drag. On the inside, its Infinite Ride liner uses a carbon thread that retains heat while wicking away moisture, with its Aegis antimicrobial coating, giving added protection from pungent feet. *£395 burton.com*

WIRED
SNOW SPECIAL
GEAR
20 15

BURTON CUSTOM MYSTERY

To mark 20 years of its Custom snowboard, Burton has come up with its lightest design to date, a cambered all-mountain style with medium flex, enhanced shock absorption and durability. It has the optimum balance of control and float for an aggressive ride that can tackle a multitude of vertical terrains. *£980 burton.com*

HARDWARE

Boot up, it's snow time

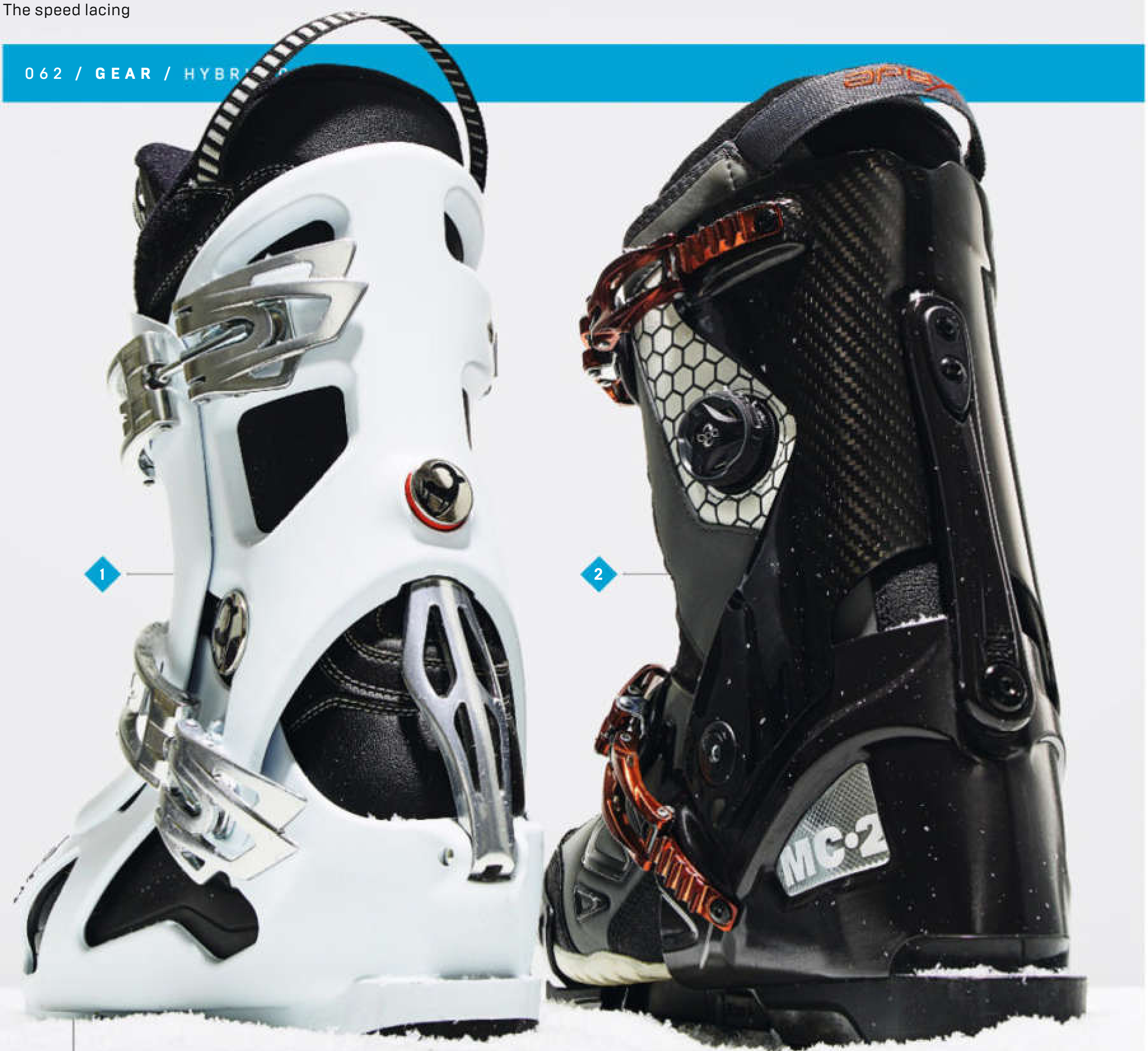
WIRED steps into the next generation of ski gear – hybrids that work on and off the hills

1. DAHU JOE & JANE

These boots wrap a removable exoskeleton around a rubber-soled moon boot. The inner boots are comfortable for all day wear (you can even drive them) and the ski boots are rock solid. The speed lacing works but there isn't space for the loose laces. Otherwise these would be perfect.

9/10 *€590*
dahusports.com

Materials Grilamid L Polyamide 12 (exoskeleton); Primaloft insulation (boot)
Flex rating 100
Features EVA heat-mouldable liner, tunable suspension
Weight per boot 2.6kg



SNAP TO IT
The exoskeleton takes less than a minute to put on – after a few tries

2. APEX MC-2 CARBON

This versatile hybrid is a snowboard boot that becomes a ski boot by slotting into a carbon-fibre cuff. With its tension-wire Boa Focus lacing and 18 points of closure, this is the most comfortable ski boot WIRED has tested – and one of the most responsive. Shedding the shell is simple, but the external frame feels flimsy.

8/10 *$1,036*
apexskiboots.com

Materials carbon fibre; glass-filled nanofibre
Flex rating 120-140
Features EVA heat-mouldable inner liner; micro-adjustment buckles
Weight per boot 2.8kg

PHOTOGRAPHY: SUN LEE

KNOMO
LONDON
LIFE ORGANISED
KNOMO.COM

HARDWARE

SALOMON X-MAX 170

This ski is very responsive. The X-Max has a nice "ping" at the apex of the turn, just as in top-end slalom skis, and Salomon has lightened the tip to allow slightly more control into the turn. In fact, if you hold the ski up to the light, you can actually see through the tip. Just as important is that the edges feel stable in longer turns, giving the skier greater all-round confidence. **8/10** *£515 snowandrock.com*

Length 170cm
Weight 1.96kg
Bindings
Salomon
XT12 Ti X-Track

Piste de résistance

WIRED compares two pairs of the latest all-mountain skis

HOW WE TESTED

Doug Clayton, assistant head of the Snowsports School at The Snow Centre (thesnowcentre.com), put two pairs of 2016 season skis through their paces at the Hertfordshire slope's 160-metre indoor run. Points were awarded for responsiveness, performance and ease of carving.

ATOMIC NOMAD BLACKEYE TI

The Nomad is a little longer than the X-Max. We liked the design, but there's no noticeable rebound from exerting pressure on the centre of the ski and it feels quite damp midway through the turn. The 15 per cent rocker (the intentionally raised ski tip and tail) makes the Nomad very user-friendly for turns, but it's not an all-rounder. **7/10** *£475 snowandrock.com*

Length 174cm
Weight 2.2kg
Bindings
Atomic XTO 12

PHOTOGRAPHY: SUN LEE

The new 800 Series Diamond
didn't get better by chance.
It got better by change.
868 changes to be precise.

Bowers & Wilkins

bowers-wilkins.co.uk

88

RUE DU RHONE

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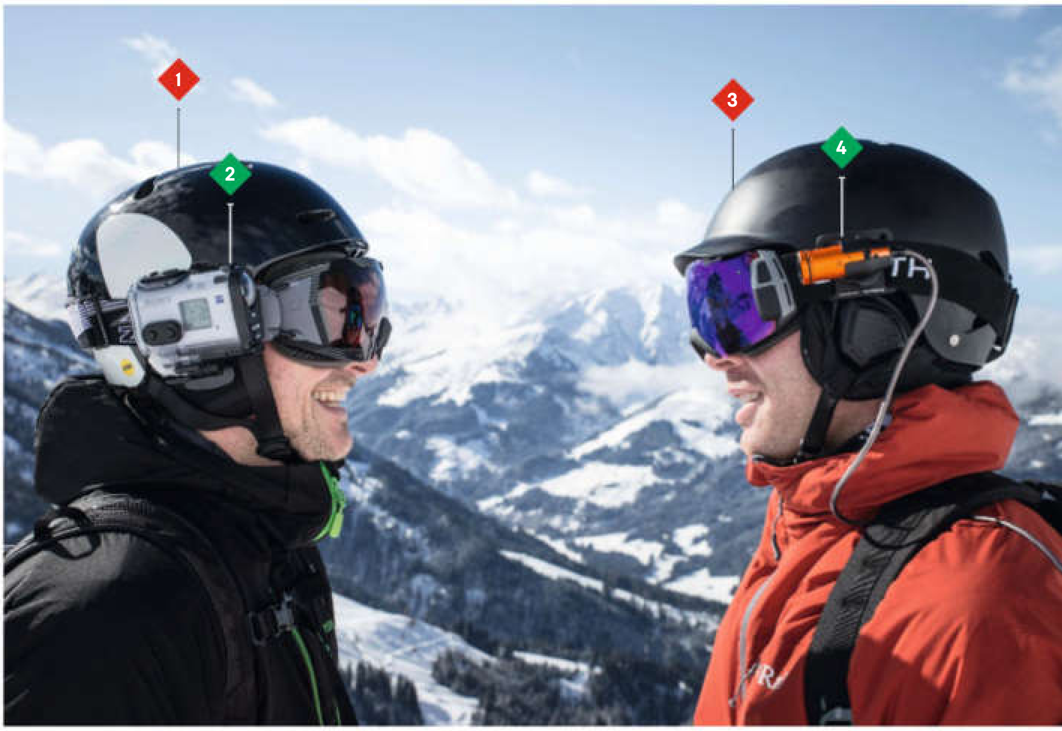
HBO RATPAC WARNER BROS. PICTURES

Heads up for a smooth ride

4K video cameras and audio-enabled crash helmets take to the mountains



Jeremy White (*left*) and Henry Farrar-Hockley on the slopes of Westdendorf

🟩 **TECH**

🟥 **SAFETY**

1. POC FORNIX COMMUNICATION

POC has taken its Fornix helmet and added Beats by Dre headphones and a mic built into the padded neck roll. Although not as high spec as Outdoor Tech's Chips Bluetooth kit, it still worked once the wireless system ran out of battery on the mountain. 8/10 *€250 pocsports.com*

Weight 420g
Max volume Not stated (but WIRED was impressed)
Play time Indefinite
Features 1.3m cable, smartphone-compatible cord control

2. SONY FDR-X1000V

WIRED found the video and audio quality to be superb, with high levels of contrast. However, the UI on the remote and the cam itself were not intuitive. At 114g, you know you are wearing the camera on your helmet and it was hard to strap the unit on sturdily enough to stop it shaking when on bumpy terrain. **7/10** *£359 sony.co.uk*

Image sensor 1/2.3-type back-illuminated Exmor R CMOS sensor
Video quality 3,840 x 2,160/30p/25p
Processor BIONZ X
Features Waterproof to 10m, burst shooting, wind noise reduction, live streaming, Wi-Fi and NFC sharing

3. BERN WATTS HARD HAT

This helmet has an AVS shell and moisture-wicking foam liner. Rather than using an integrated sound system, WIRED chose Outdoor Tech's Chips, a pair of Bluetooth speakers with good sound that drop into the ear pads. 7/10 *£85 ellis-brigham.com (hat), $130 outdoortechnology.com (speakers)*

Weight 500g
Max volume 112dB
Play time 10 hours
Features IPX4 sweat and water-resistant

4. PANASONIC HX-A500E

This 4K barrel cam keeps its weight down to just 31g by rehoming its power supply, micro SD slot and controls to a cabled LCD display worn on the upper arm. The battery life is reasonable and the image quality excellent. However, the audio distortion from skiing at speed is substantial – although a windjammer is now available. **8/10** *£380 panasonic.co.uk*

Image sensor 1/2.3-type BSI MOS (12.76MP)
Video quality 3,840 x 2,160/25p
Processor 1GHz dual-core ARM Cortex-A9
Features Wi-Fi and NFC sharing, water-resistant

Digital extra!
Download the WIRED app to view footage from the video cameras

PHOTOGRAPHY: CHRISTOPH OBERSCHNEIDER

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Ultra HD up to 4x resolution of Sky HD: (3840 x 2160 vs 1920 x 1080 pixels). Compatible equipment and min line speed required. See bt.com/ultrahd. Approx 1 live Ultra HD event per week across the season.

CLOTHING

Summit meeting

One mountain, two synthetic ski jackets. Which was the cosiest?

JACKETS

1. NORRONA LOFOTEN ALPHA

The lightweight Alpha has Polartec Alpha synthetic insulation for extra breathability. It can be worn as a water- and wind-repellent shell or as a middle layer. And it's warm: only when WIRED was caught in a snowstorm did the cold penetrate the jacket. ***8/10*** *£249 norrona.com*

Insulation 100g/m^2
Weight 480g
Features Storm hood; integrated stuff sack; elasticated cuffs

PHOTOGRAPHY: SUN LEE

A Polygiene mesh with antimicrobial silver salt tames nasty odours

The Rab's lightness makes it suitable for a wide variety of sports

2. RAB STRATA HOODIE

This slim-fit jacket's combination of Polartec Alpha insulation with a water- and wind-resistant Pertex Microlight outer meant that the disconcertingly thin shell was effective at retaining heat. Sweating was kept to a minimum thanks to its breathable membrane, and the only factor preventing it from maximum points was the efficacy of its waterproofing when a blizzard closed in. ***8/10*** *£160 rab.equipment*

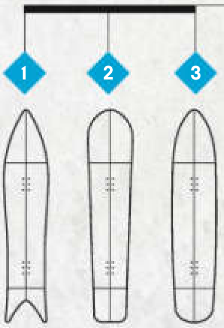
Insulation 80g/m^2
Weight 465g (large)
Features roll-up hood; integrated stuff sack; hem drawcord

Be the chair of your own board

Take time out to carve your own design from YES's fibreglass plank

YES CLARK

The Clark takes an unusual approach to snowboard design in that the aesthetic is very much left up to you. It's described as a Shape It Yourself board. Its makers hope to create an open-source community – sharing tips on the most effective ways to cut, carve and sand this poplar, resin and fibreglass plank in readiness for the mountain. But if you do need help, YES Snowboards has produced a handful of downloadable templates to get you started. *$tbc yesnowboard.com*



1. The Classic
2. The Alaia
3. Surf template

SNOW APPS

WIRED put GPS skiing apps through their paces and plotted the results

SKI TRACKS
Providing up to 14 hours of track recording, this iOS- and Android-compatible app covers all the GPS bases, all the while preserving battery life. **7/10** *79p corecoders.com*
Features Embedded geo-coded photos; track sharing; battery monitor

EDGE SKI
Edge Ski is simply a prettier version of *Ski Tracks*. It can be used in full offline mode to save battery and charges, but WIRED found it to be a little glitchy. **8/10** *Free edgemobile.co*
Features Real-time resort data; weather forecasts; friend challenges

SNOCRU
This well-designed app gives you the option to log your equipment, earn badges for alpine achievements and establish your own "Cru" – plus see friends' locations in real time. **9/10** *Free snocru.com*
Features Resort forecasts; social leaderboards; Cru activity feeds

Reflected glory

Which of these HUD-driven ski goggles has the edge?

1. SMITH I/O RECON

Like all other integrated-display goggles, the I/O Recon is powered by Recon Instruments' SNOW2 wearable computer, and the most relevant function is the live speedometer. The software feels laggy but the goggles themselves are well engineered. **6/10** *£560 smithoptics.com*

Features
Buddy tracking; jump analytics; five-times anti-fog lens

2. OAKLEY AIRWAVE 1.5

These are also powered by Recon, so you get a similar, flexible, Bluetooth-enabled screen. Onboard GPS instantly updates your speed, height, distance and airtime. The app is clear and easy to use; like the Smith, the software is sluggish but battery life was good and the Airwaves lasted all day without a top-up. **6/10** *£520 uk.oakley.com*

Features High Definition Optics lenses; GPS; Bluetooth; buddy tracking

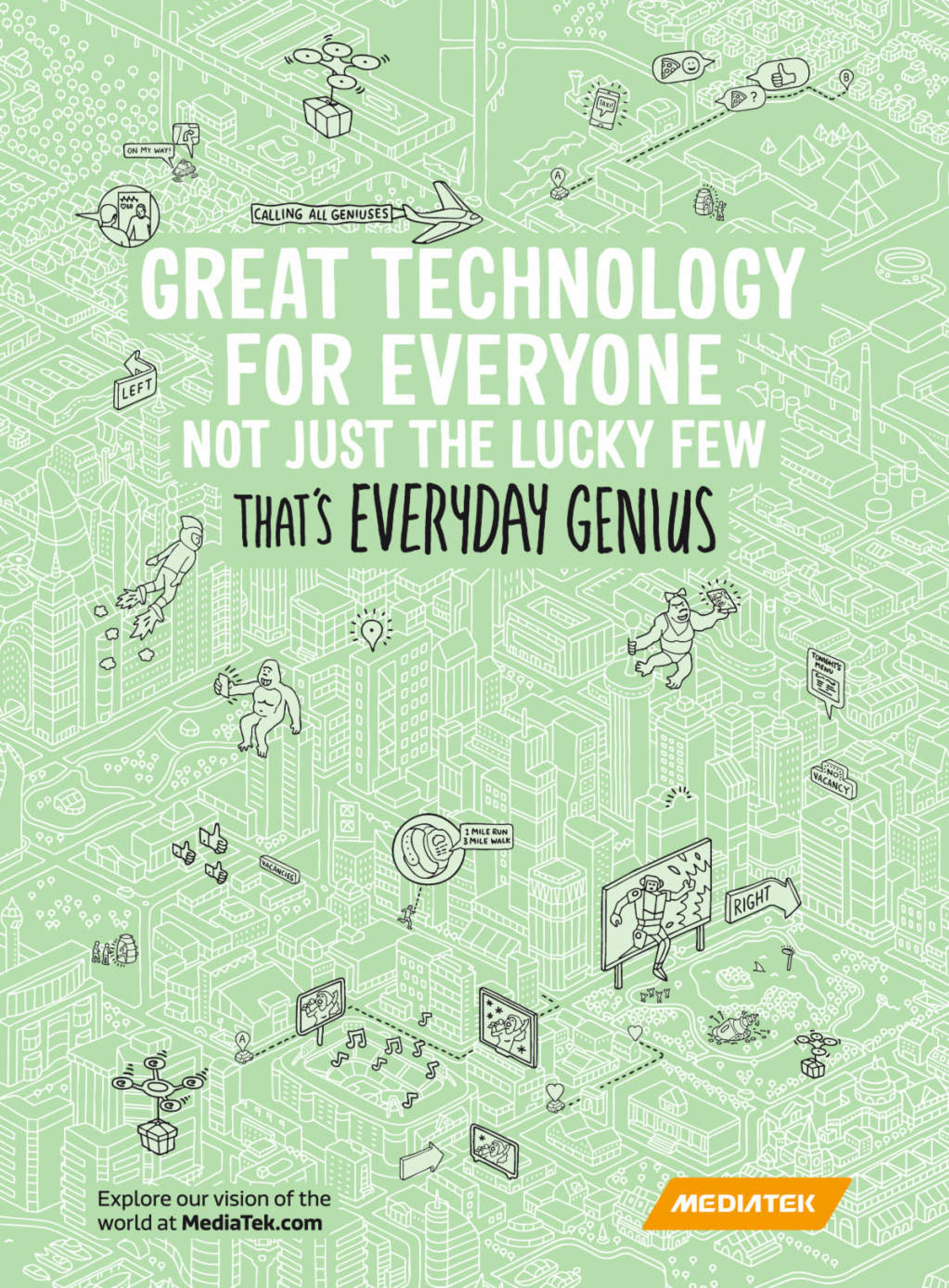
3. ZEAL Z3 LIVE

Turn on the SNOW2 display by tapping a button on the side of the frame – it's a nice touch, but it's easy to hit by mistake. The anti-fog lenses worked well but the size of the Z3s made them uncomfortable. **5/10** *$499 zealoptics.com*

Features 16:9 widescreen in-goggle display; smartphone connectivity

Special thanks to the SkiWelt Wilder Kaiser - Brixental (skiwelt.at) / WIRED also tested the Black Diamond Dawn Patrol LT Shell jacket (eu.blackdiamondequipment.com) / WIRED editor David Rowan is an investor in Edge Ski. He had no involvement in the commissioning of this article

PHOTOGRAPHY: SUN LEE; ROGER STILLMAN



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IDEAS BANK

The dark net: where you'll find Tesla and Tesco

JAMIE BARTLETT

The dark net is synonymous with the secretive world of whistleblower sites, illegal pornography and the Silk Road drugs marketplace. Things that, for reasons good and bad, people have chosen to keep hidden. This network – technically called Tor Hidden Services – is an encrypted part of the internet, where URLs are a string of meaningless numbers and letters that end in ".onion", accessed using a browser called Tor. The software was built by the US Navy but is now open source. It allows people to browse the net without giving away their location, by encrypting the IP address and then routing it through several computers around the world that use the software. Tor can be used on the normal net but is also the route into this dark net of uncensored sites.

But the dark net won't stay dark for much longer. Because of a demand for secure internet access and user privacy, soon enough big businesses, newspapers, internet companies – and then all of us – will join the dark net. Within five years, you'll be able to choose to access all your favourite brands on either the dark or the normal net.

The dark net also has another scarce business premium: creativity. Take the Silk Road online market, the most infamous site on the dark net, which was almost universally misunderstood by those who reported it. Yes, all and any drugs were available to buy and sell before the site was closed down in October 2013 – and that's not a good thing. But it was also a dazzling, phenomenal achievement. In the world of business, its founder Ross Ulbricht would be feted as a "guru", because he created a competitive, functioning market in the most hostile conditions imaginable: buyers and sellers were anonymous and never met; and law enforcement was constantly trying to shut it down. But using clever encryption, good design and imagination, the Silk Road tilted the balance towards the buyer. Dealers were polite, attentive and consumer-centric. There were loyalty systems, special offers and mystery shoppers. Product quality was kept high and prices low thanks to consumer power. It wasn't perfect, but more than a million successful transactions went through the site over an 18-month period.

These online markets – there are many more now than when the Silk Road was busted – are relentlessly innovative. People pay with the bitcoin cryptocurrency, which can be exchanged easily enough for real-world currency, and offers its users a high degree of anonymity. When a flaw was spotted in the payment system (site admins held on to buyers' money until transactions were complete, but were running off with it) the community developed a secure payment method, called "multi-sig escrow", whereby money is transferred only if two of the three parties sign off with a digital signature. To help keep buyers anonymous, developers created "tumbling" services, which are a sort of micro-laundering system that obscures who is sending bitcoins to whom.

Jamie Bartlett is director of the Centre for the Analysis of Social Media

That combination of security, freedom and creativity is one reason use of the Tor browser is increasing – especially since the revelations of Edward Snowden. Aphex Twin announced his 2014 album, *Syro*, simultaneously on the normal net and on the Tor network. Facebook released a Tor Hidden Service version. According to Alec Muffett – a software engineer at Facebook who helped to set it up – it lessens the risk its users are subject to certain hacks (such as a "man in the middle" attack) or accidentally end up on a Facebook-lookalike phishing site. That's because it provides end-to-end communication from your browser to the Facebook data centre.

Its underground darkness is also exciting. Restless marketers and advertisers are always looking for ways to be heard above the online noise. I've been approached by several marketing companies asking advice about setting up dark-net sites. Soon enough a major business will run a daring ad campaign on the dark net, and set up a site there, with the promise of security. News outlets and social-media networks will also jump in, as users demand more privacy. Then Metcalfe's law kicks in: the more people on a network, the more interesting it becomes to others, making it more interesting – until everyone has joined. And when everyone's on the dark net, it stops being dark. It's just the net.

ILLUSTRATION: YUKAI DU

JUAN ENRIQUEZ

How one street corner changed the world

Juan Enriquez is managing director of Excel Venture Management. He also co-wrote *Evolving Ourselves* (Oneworld)

If one had to pick a single corner, anywhere on the planet, as the most innovative and productive crossroads in history, the intersection of Vassar Street and Main Street, in the new world's Cambridge, Massachusetts, would be a leading candidate. A couple of decades ago, much of the area was a ragtag collection of warehouses, parking lots and old barracks. Now this one corner may generate one per cent to two per cent of the future global economy and may be a model for creating jobs, knowledge and power in other global cities.

Begin a short tour with the corner's dumpiest building, a thin, seven-storey sliver of dark brown with a mediocre plaza in front, the Whitehead Institute. Most of the seventeen core faculty don't teach much, but during the first decade of this century, their research had the greatest citation impact among the world's top 15 life-science and genetics departments. And, as they helped birth entire fields of research, developing our understanding of genetics, genomics and epigenetics, these individuals also helped launch enormous companies such as Genzyme and Millennium.

When the Whitehead got too small for genomicist Eric Lander's ambitions, he launched a flashier and brasher newcomer next door. The Broad Institute's gargantuan gleaming glass lobby is filled with early gene-sequencing instruments. Its multimedia screens boast that this is one of the world's largest gene-sequencing and research factories. The Broad's strategy is different from that of the Whitehead; instead of concentrating a few in an ultra-exclusive bioclub, Broad bridges MIT, Harvard and most of the hospitals in Boston. Its 2,000 members extend outwards, partnering with tens of thousands of others globally. Those working at the Broad are not averse to commerce; its director alone helped to build Foundation Medicine, Verastem, Millennium, Fidelity Biosciences, Courtagen, Aclara and Infinity Pharmaceuticals among many other leading companies.

Cross the street and enter the new Koch Institute for Integrative Cancer Research: an unusual cancer facility in that there are no day-to-day patients, nor is it part of a medical school. Its research focuses on the very basics of cancer: how cells go rogue, cures involving nano molecules, a variety of ingenious devices and early diagnostics. By mixing and matching biologists with electrical, chemical, mechanical, materials science and bio engineers, the Koch reiterates the lesson that **productivity, patents and companies take off when you blend disciplines. There are no "departmental** common rooms" – you eat and chat with everyone else, and you might run into Bob Langer (the world's most prolific bio-inventor), Darrell Irvine (who uses one's own immune system to attack cancer), Sangeeta Bhatia (a nanoengineer who detects cancer very early), Nobel laureate Phil Sharp and MIT's ex-president Susan Hockfield. And again, their discoveries translate into companies with the market capitalisation of small and mid-sized countries.

Next door sits a huge Frank Gehry building that looks "a little post-earthquake"; this is one weird but interesting place, harbouring an extraordinary hodgepodge of disciplines. Within the lobby café you might run into the creator of the world wide web, the founder of the free-software movement and some of those who let loose the first computer worms (for which they are most sorry). Conversations range from artificial intelligence, to robots, programming cells for every imaginable purpose, the next generation of the web, the future of computing, simultaneously grading millions of homework assignments, all with a dab of Noam Chomsky's linguistics commentary drifting down from the top floor.

Cross the street and you enter a huge, gleaming white rectangle that brings together everyone studying the brain: psychologists, psychiatrists, electrical engineers, neurologists, radiologists and dozens of other tribes that study consciousness. The building literally straddles a railway line, so that lunchtime conversations between departments such as Brain and Cognitive Sciences, Learning and Memory, and Neural Imaging can run uninterrupted. Proximity matters; Sloane's Thomas Allen found we are four times as likely to communicate with someone two metres away as someone ten times further away and often unlikely to communicate much with someone on a different floor or building. Tight clustering is not new at MIT; provost Marty Schmidt recalls that in 1916, when the greatest universities were busy building isolated departments in pastoral settings separated by carefully landscaped quads, MIT built out the "infinite corridor", an

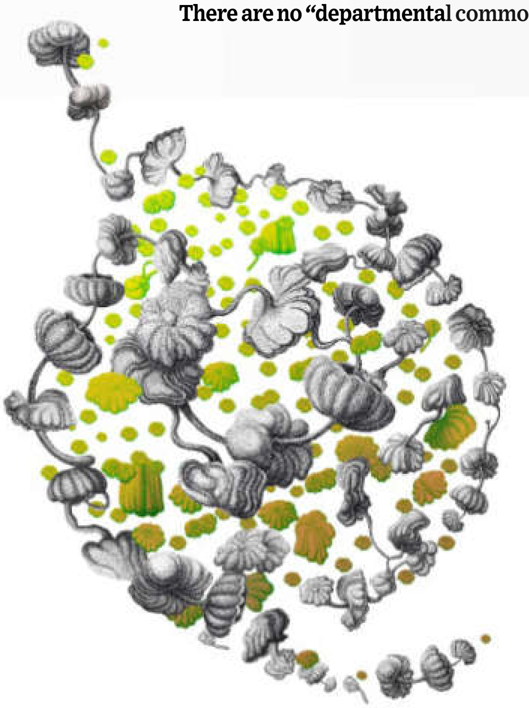


ILLUSTRATION: ARMANDO VEVE; MATT CHASE

endless, massive building. Every department still wants to be "close in".

The sixth building on this extraordinary corner, Novartis, focuses on private research, and represents a huge migration from Basel in Switzerland towards the MIT campus, becoming Cambridge's largest employer. Pfizer, Sanofi, Amgen, Biogen-Idec and hundreds of others cluster nearby. The decision to promote commerce alongside research is a critical differentiator in MIT's success and competitiveness. One need only count the number of construction cranes, new restaurants, cinemas and museums in Boston to understand what a vibrant bridge between research and startups means overall city life. MIT's alumni already generate companies with sales equivalent to more than two trillion dollars, the same as the world's ninth largest economy, India.

Attracting a critical mass of really, really smart nerds and intermingling them with entrepreneurs and large companies is essential to growing and maintaining a global city. Ed Roberts, an expert on MIT's impact, recalls how a few conversations, around the greasy Formica tables of the old F and T Diners, eventually engendered this behemoth of a job machine. In the past decade alone, 18 out of every 100 MIT alumni launched companies, eight per cent of them near MIT. The state of Massachusetts now hosts 6,900 startups launched by MIT alumni. Combined, they represent 26 per cent of all state sales.

Balancing research and entrepreneurship, Korea, Taiwan, the Netherlands, Singapore and a few others have also built global economic powerhouses based on city states. The good news? A newcomer can quickly overtake former powers. The bad news? By its very nature a knowledge economy can be a fragile phenomenon because, as Phil Sharp likes to quip, "Innovation walks on two feet." A few 747s can add or remove large chunks of innovation. In this era of increasing political polarisation, public officials ought to pay attention, by combining careful urban planning, support of entrepreneurs and academic recruitment. Because by attracting the best and the brightest, one can change not just a city but the world.

BY SIMON PARKIN

Role play in gaming is an empathy machine

You stand in a locked room. In ten seconds' time the door will swing and shudder open and your violent partner will stride in, spoiling for a fight. What do you do? Can you evade the seemingly inevitable? Or: you're an immigrant in America, selling newspapers to commuters. But people aren't buying too many papers these days. It looks like you won't make the rent. You arrive home to find a note from your landlord. Get rid of your cat, it reads, or face eviction. Will you take the risk, or cast out your only companion? You're an immigration inspector working at an east European border checkpoint. Each day you must abide by a set of increasingly complicated rules governing who's allowed to enter. An elderly man creaks up to your booth. His papers are in order; you let him through. His wife is next in line. You scan her papers and immediately notice a problem with her visa. Let her through and, if found out, you will pay a penalty. Do you uphold bureaucracy or save the marriage?

These are just three of the scenarios into which video games have placed players. *10 Seconds in Hell* uses the medium to communicate the terror of domestic abuse. *Cart Life* offers an affecting video-game study of life in America for those working on the poverty line. *Papers Please* is a study of the ways in which red tape can entangle people, and even decide their fates. During the medium's first two decades, video games mainly presented us with the opportunity to enter situations too dangerous, rarefied or expensive for reality. So we became the racing-car driver, the marine, the superhero, a footballer and so on. More recently, the rise of easy-to-use video-game-creation software, and the lowering of the barriers of game distribution, have vastly expanded the range of people making and selling games.

Video-game themes have broadened in kind. In *Prison Architect* we are made responsible for both the architectural layout of an American prison and its day-to-day running, balancing the needs and human rights of our prisoners with the bottom line. *Phone Story* examines the plight of sweatshop workers assembling smartphones for western clients. *Coming Out Simulator 2014* is an autobiographical game about a young man trying to tell his parents about his sexual orientation. Games increasingly allow us to experience something of other people's lives and predicaments.

The film critic Roger Ebert described film as "a machine that generates empathy". Film, he said, allows us to "understand a little bit more about different hopes, aspirations, dreams and fears". Games are better poised than almost any other medium to do this.

Moreover, video games are not only a way for an audience to experience a life outside their own, but also a powerful way for a person to invite others into one's own personal history and perspective, to not only view the story from the sidelines, but from the inside. And by becoming a soldier, newsagent or victim of domestic abuse, we begin to understand the world and its people a little more. The potential of these empathy machines is something that we are only just beginning to explore.

Simon Parkin is an award-winning critic and journalist.
He is the author of *Death by Video Game* (Serpent's Tail)

BY MARTIN FORD

Keep learning. The robots are behind you all the way

In May 2015, a team of researchers from the University of Science and Technology of China and Microsoft's Beijing office announced a new system, based on rapidly advancing "deep learning" technology, that's capable of outperforming the average person on the kind of verbal-reasoning puzzles found in IQ tests. Deep learning uses artificial neural networks, which operate according to the same essential principles as the biological neurons in the brain. Although neural networks have been used to perform basic pattern-recognition tasks for decades, the past few years have heralded dramatic breakthroughs that now allow deep-learning neural networks of unprecedented power and complexity to be employed in areas such as image recognition, language translation and problem solving. A team at the University of California, Berkeley used deep-learning techniques to build a robot that figures out how to perform very dextrous tasks, such as screwing the top on a bottle, with the same speed and precision as a person.

Deep learning offers just one of the more vivid illustrations of how smart software algorithms are becoming ever more capable at solving problems, making decisions, and – most importantly – learning to do new things. This rapidly advancing ability to learn and adapt has especially dramatic implications for the job market because, for the first time, machines are encroaching on the intellectual capability and adaptability that has, so far, ensured that most workers are able to remain relevant as technology progresses.

The impact on more routine, repetitive jobs is already evident. A recent analysis by an American consulting firm found that the number of people employed in the finance departments of large corporations, for a given level of revenue, has collapsed by about 40 per cent since 2004. Routine work areas, such as bookkeeping and accounts payable and receivable, are increasingly being taken on by smart software, and the people who used to have secure white-collar jobs performing these tasks are finding themselves in the unemployment queue.

Workers who have higher education levels may be tempted to take comfort in the belief that their jobs are non-routine and, therefore, beyond the reach of the machines. However, the frontier is advancing rapidly, and software has already progressed far beyond simply automating rote repetitive jobs. Smart systems are writing news articles, performing sophisticated legal-document reviews and evaluating medical images. In fact, "routine" may not be the best word to describe the jobs most likely to be automated. A better term might be "predictable". Could another person learn to do your job by studying a detailed record of what you've done in the past? Or could someone become proficient by repeating the tasks you've already completed, in the way a student might take practice tests to prepare for an exam? If so, then there's a good chance that a machine-learning algorithm may eventually be able to figure out how to do much, or all, of your job.

Martin Ford is the author of *The Rise of the Robots: Technology and the Threat of Mass Unemployment* (Oneworld)

ILLUSTRATION: DAVID MCMILLAN

The conventional solution to technology-driven job losses has always been ever more education and vocational training. As machines and smart software eat away at low-skill jobs, workers are urged to retool themselves and continually seek higher-skill positions. It turns out, however, that workers are not the only ones who can climb the skills ladder: computer technology is proving remarkably adept at the same feat. Evidence for this is in the job market. In the UK, average starting salaries for graduates with degrees fell by about 11 per cent over the five years from 2007 to 2012, from £24,293 to £21,701. And in the US, any recent graduate can tell you that we have entered the age of the degree-bearing barista: half of new graduates end up taking jobs that don't use their education.

The upshot is that smart machines may eventually create an economy where a large number of workers cannot remain relevant. That will force us to confront the fact that we have entered a new age – in which the relationship between workers and machines has been transformed. Adapting to that new reality could well be one of the seminal challenges facing us in the coming decades.

SECURITY
CLOUD
MOBILITY
BIG DATA

HPxWIRED

Enterprise Futures

In 2014, HP celebrated its 75th anniversary – now it's embarking on a new era. The leading IT services and product business is splitting into two distinct companies – with one arm focusing entirely on providing enterprise solutions

1

SECURITY

The white hats are fighting back

Smarter software is changing digital security, making it faster, safer and less labour-intensive – good news for everyone

Security
Individuals and companies are more exposed than ever before. So how can we stay secure in a digital age?

Organisations are inundated by "tsunamis" of security data, says Tim Grieveson, chief cyber and security strategist for EMEA at HP. And the task of translating data into insights is becoming much harder.

With the variety and sophistication of attacks increasing, Grieveson argues it's critical to take a holistic approach to enterprise security. "The bad guy is getting smarter," he says. But so are the good guys. Launched in 2005, HP's Zero Day Initiative (ZDI) combines global security researchers with HP's enterprise security solutions. By running the world's largest vendor-agnostic bug hunt, HP engages experts and ex-hackers to get ahead.

In a multi-device environment it is also crucial to protect data as it travels around the network. HP's recent acquisition of Voltage Security – a leading vendor of data-centric security software solutions, allows it to do just that.

Voltage works with many of the world's largest merchants and retailers. By protecting data from the moment it is created and throughout its entire lifecycle, organisations can close the security loop. But just as data needs protecting, it can also be intelligently harnessed to provide new security insights, making organisations stronger.

"Zero-day vulnerabilities tend to follow what's popular," says Jewel Timpe, senior manager of threat research at HP Security Research. "Years ago, many people were targeting operating systems. That forced operating systems to improve, and the focus shifted to applications. As apps continue to improve their security, the focus has turned to new areas in computing – like the internet of things and SCADA."

One solution is HP's DNS Malware Analytics, which inspects a company's DNS traffic for infections. The clientless, algorithmically-driven service detects threats on servers, mobile devices and desktops, and contains them.

Data-driven security is a key trend identified by Grieveson. "Technologists are drowning in the tsunami of information overload," he says. The challenge is to turn the "data lake" into manageable "data puddles". So HP has turned to machine learning. HP Fortify is uses an organisation's application security data to improve the accuracy and efficiency of overall security. Collating data from a range of historical security scans, it reduces the strain on technologists, so they can focus on other tasks.

Yet many organisations still refuse to recognise the growing threat. For HP customers, 89 per cent of data breaches are on the application layer, not the perimeter. Grieveson believes organisations should be building security up front – and that the CISO community should be learning to talk in business terms. "Make the assumption you're going to be breached, or have been but don't know it yet, and look at how you can disrupt and manage the breach when it inevitably occurs," he argues.

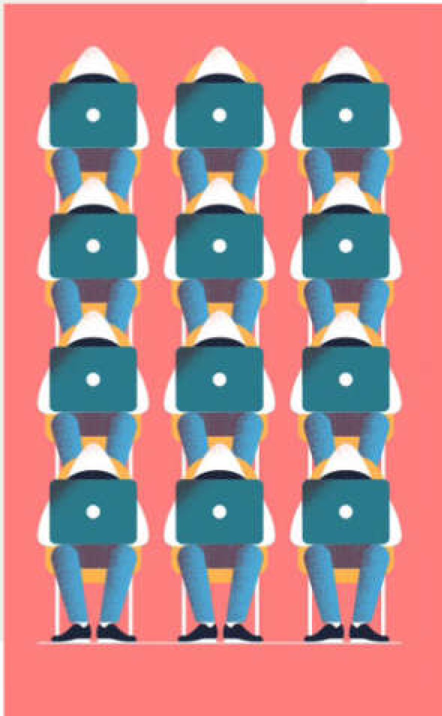


ILLUSTRATION: GIACOMO BAGNARA

2

CLOUD

The outlook is sunny for cloud computing

Breaking down the barriers of switching to the cloud means a better experience for consumers as well as businesses – big or small

According to figures from Eurostat – the statistical office of the European Union – only one in five enterprises in the EU uses cloud computing services for their business IT. Why? Insufficient knowledge about the technology. And yet the benefits are substantial – and increasingly accessible for a wide range of companies.

"By utilising the cloud you can develop far more quickly. It can open to you new business opportunities, new geographical reaches," says Xavier Poisson, vice president of cloud computing for EMEA at HP. Indeed, by combining the best of private and public cloud systems, businesses are able to employ a hybrid cloud that can scale up and down as required. For example, over busy periods such as Christmas, a retailer's cloud solutions could grow automatically to cope with increased demand and stresses.

In 2010, Société Générale, one of the largest banks in France, decided to start an automation project. With too many different application development processes spread across too many different business units, it was no longer possible to keep up the pace of development. Working with HP, it implemented a suite of cloud management solutions to tackle the issue.

The solution entailed combining HP's Operations Orchestration Server Automation and its Cloud Service Automation portal. These allowed Société Générale to manage more than 100 applications – from testing and development to a production environment. The bank's developers were freed from working on time-consuming, repetitive, valueless tasks and could spend more time on more important strategic business projects.

"Today, what needs to be understood is that in traditional IT, when you had an application, you were developing a new release of this application once or twice a year – but not more," says Poisson. "With mobility, and the need to be more agile, you've got to have a completely new development cycle, and it's essential to develop more quickly."

With a faster time to market – projects taking hours rather than days – developers could, on average, also greatly increase the number of releases they deployed. The system was also more reliable and traceable, with logs keeping track of what was happening on servers and when.

Rather than investing in and relying on legacy IT systems, where specific applications are directly connected to hardware, hybrid clouds allow organisations to develop applications as a service. By developing on open-source, platform-agnostic hybrid cloud systems, SMEs and global organisations can be far more flexible – and also save time and money in the long-term.

In order to drive development of European cloud services, HP has called for the creation of a "cloud of clouds", made and secured locally. The company believes such an ecosystem would create more agile business services, job opportunities and increase competitiveness across

Cloud
Some of the world's fastest-growing firms are built on the cloud – providing always-on access to data from anywhere. It's time for all businesses to feel the benefit.

> *"With mobility, with the need to be more agile, you've got to have a completely new development cycle"*

the continent. All while keeping data safe and secure within the borders of the EU. To make the ambition a reality, HP has launched Cloud28+, an entirely self-governing non-profit entity that will work to increase cloud service adoption in the region.

The figures in support of the initiative are compelling. Market research conducted by IDC in 2012 looked at how the European cloud market would develop with and without political support by the year 2020. Cloud services supported by policy could increase EU gross national productivity by €250bn, creating 3.8 million jobs. Without political support the European cloud market would only generate €88bn and 1.3 million jobs. It appears to be an obvious choice.

Speaking about the launch of Cloud28+, Poisson remarked that by promoting open source technologies and encouraging the creation of a greater European cloud ecosystem, HP was offering greater business value for its customers – and Europe in general.

ILLUSTRATION: GIACOMO BAGNARA

3

MOBILITY

Keeping compatible in a multi-device era

How to avoid data loss and platform clashes when employees and consumers work and play across multiple devices

Mobility
Today we all work and play (as well as waste time) on the move. Now the software needs to keep up with how users are behaving.

The consumerisation of enterprise IT is felt nowhere more keenly than in mobility. There will be an estimated 12 billion connected mobile devices by 2020 and businesses that harness this growth will thrive.

"The challenge for organisations is to mobilise their business processes and gain a competitive advantage," says Pierre Mirlesse, general manager of HP's mobility business in EMEA.

For many, the transition from Windows 7 to Windows 10 will enable a secure, integrated mobile workforce. The multi-OS environment, fuelled by iOS and Android, continues to thrive, but with increased pressure to standardise and reduce cost, explains Mirlesse.

But the integration of products such as Office 365 and Skype for Business requires more than adopting Windows 10. "To make it work, it's not only about the Microsoft product, that's clear," explains Norbert Reil, technology consulting director EMEA at HP. "You need to master the end to end implementation, from data centre infrastructures to the full application stack, and low latency, quality of service networks."

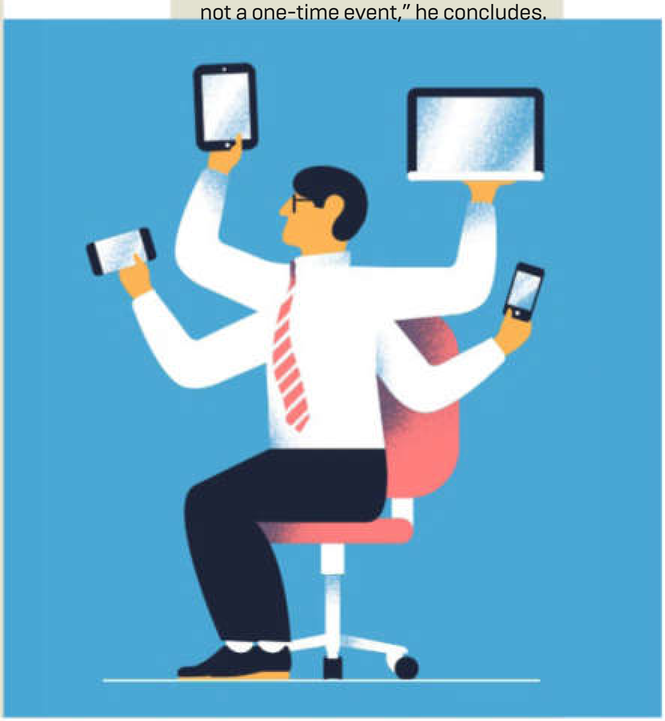
HP already manages 6.5 million desktops, making it the number one desktop services company in the world. And with 48,000 Microsoft-trained professionals, it knows Windows inside out. "Security is paramount," says Mirlesse, arguing that this is where Windows 10 really has an advantage. "Security over a mobile environment can only be achieved if you have integrated management of services."

Mobility is also making a huge difference in healthcare. Working with HP, Cambridge University Hospital has become one of the UK's leading digital hospitals. Patient information is now stored entirely digitally, making it more secure and easier for medical experts to access. This has improved the overall functioning of the hospital and, crucially, the quality of care patients receive.

"Such industry-specific insights are key to get to the real benefits," says Reil. He also points to engineers, typically tied to their desks due to the graphics-heavy nature of their work, as a prime example of where mobility can make a huge difference. Empowered by virtualised workstations with high-end graphics cards they can collaborate with their R&D network from anywhere without having the data and IP leaving the secure data centre.

"There's a blurring of professional and personal life," says Mirlesse. "You use the same devices in your personal life as at work. We've got to think about how that workplace is transforming along with the workforce and work style."

"Going from today's workplace to tomorrow's is going to be a journey. It's not a one-time event," he concludes.

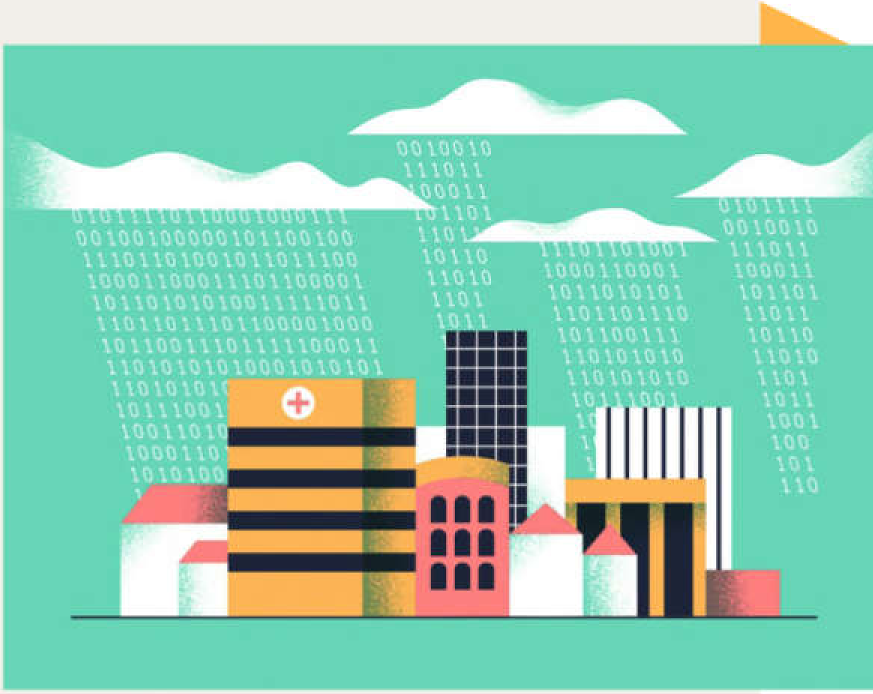


4

BIG DATA

Big data leads to a connected universe

Vast data sets – and the ability to quickly and efficiently find patterns within – could bring about the next era of innovation



Big data was a term that arrived on the scene after we were all doing it," says Gareth Martin, HP's head of big data solutions in EMEA. But to become truly useful, big data needs a bigger brain. From healthcare to farming and conservation to policing, intelligent collection and analysis of data will play an increasingly crucial role.

"We'll continue to build on big data and the concept for many years and it'll change as the technology changes," says Martin. Right now the biggest question facing businesses looking to leverage big data is how to handle it.

The ability to analyse and make informed decisions from vast quantities of data is the next big hurdle, but one that some are already achieving. With the help of HP, environmental organisation Conservation International (CI) has been able to collect data from sources as disparate as camera traps and environmental sensors to better understand the threats faced by endangered species.

Using HP's technology, CI was able to dramatically improve the accuracy and speed of critical data analysis. The bespoke software platform, known as HP Earth Insights, has handled more than three terabytes of data, including two million camera trap photos and four million climate measurements.

"We're almost seeing the industrialisation of big data, much more efficient systems to handle it, much more effective ways to analyse it and easier ways for data scientists to interact with it," explains Martin.

But companies that don't take a disruptive approach towards big data risk being left behind. Martin Houghton, HP's chief data officer for EMEA, explains the company is seeing a big push towards the creation of data laboratories in businesses.

"Industry is starting to realise that data is a potential ingredient in an experimentation process," he says. "You can learn things that you didn't know before and you might not even know what it is you're looking for before you start."

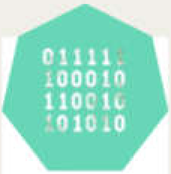
Companies that are willing to experiment with data could find new products, services and market strategies. Auto-maker Volkswagen has already established an experimental data lab to do just that, allowing employees to quickly develop software prototypes in a laboratory environment and put them to the test. Creativity and experimentation, powered by big data analytics, could help develop new solutions.

Increasingly flexible platforms allow for big data to be collected and used in unexpected locations. At the Shell Eco-Marathon, the company's annual competition to foster innovation in fuel efficiency, HP's systems allow for data to be analysed on tablets, scanners and laptops in real time from anywhere on the site.

Experiments at the Eco-Marathon have shown the challenges facing big data if it is to be scaled up from businesses and factories to entire cities. For Houghton, collection and analysis of big data will only happen once 4G – and potentially 5G – networks are more widespread.

"The true ubiquitous nature of big data has got some reliance on the ability to move data around space – and that means networks." By 2050, with 75 per cent of the world's population living in urban spaces, leveraging big data will play a crucial role in powering the cities of the future.

"What will be fascinating is when we get to the point where we're actually creating a proper connected universe, when we really see the information feeding back into our own lives," says Houghton. ***For more, see hp.com***

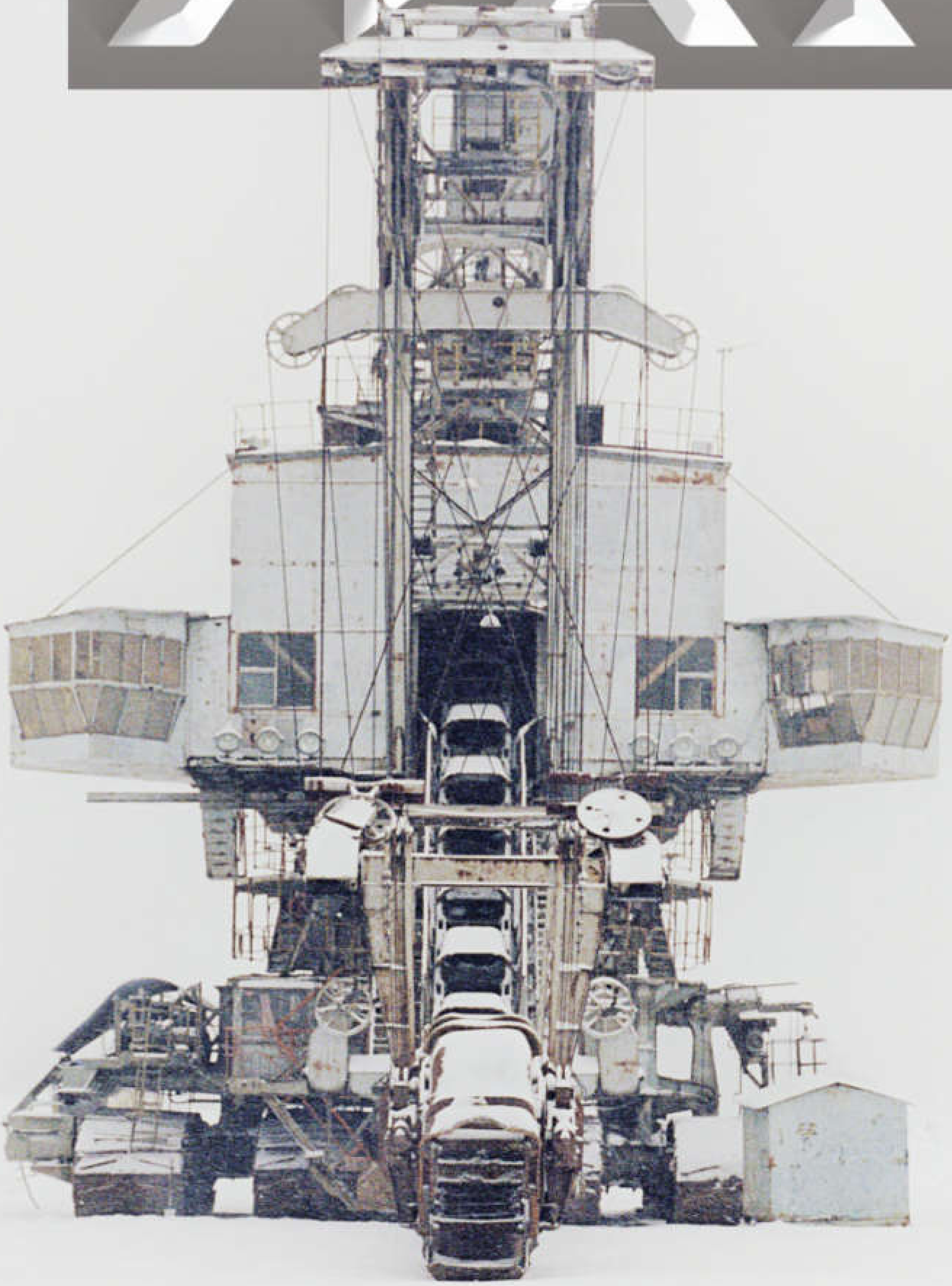


Big data
More than just a hot trend, it's time for big data to grow up and start impacting society at large.

> *"The true ubiquitous nature of big data has got some reliance on the ability to move data around space"*

ILLUSTRATION: GIACOMO BAGNARA

PLAY



The former USSR is a graveyard of Cold War projects. Pictured here is an excavator in a Moscow quarry

Incredible hulks

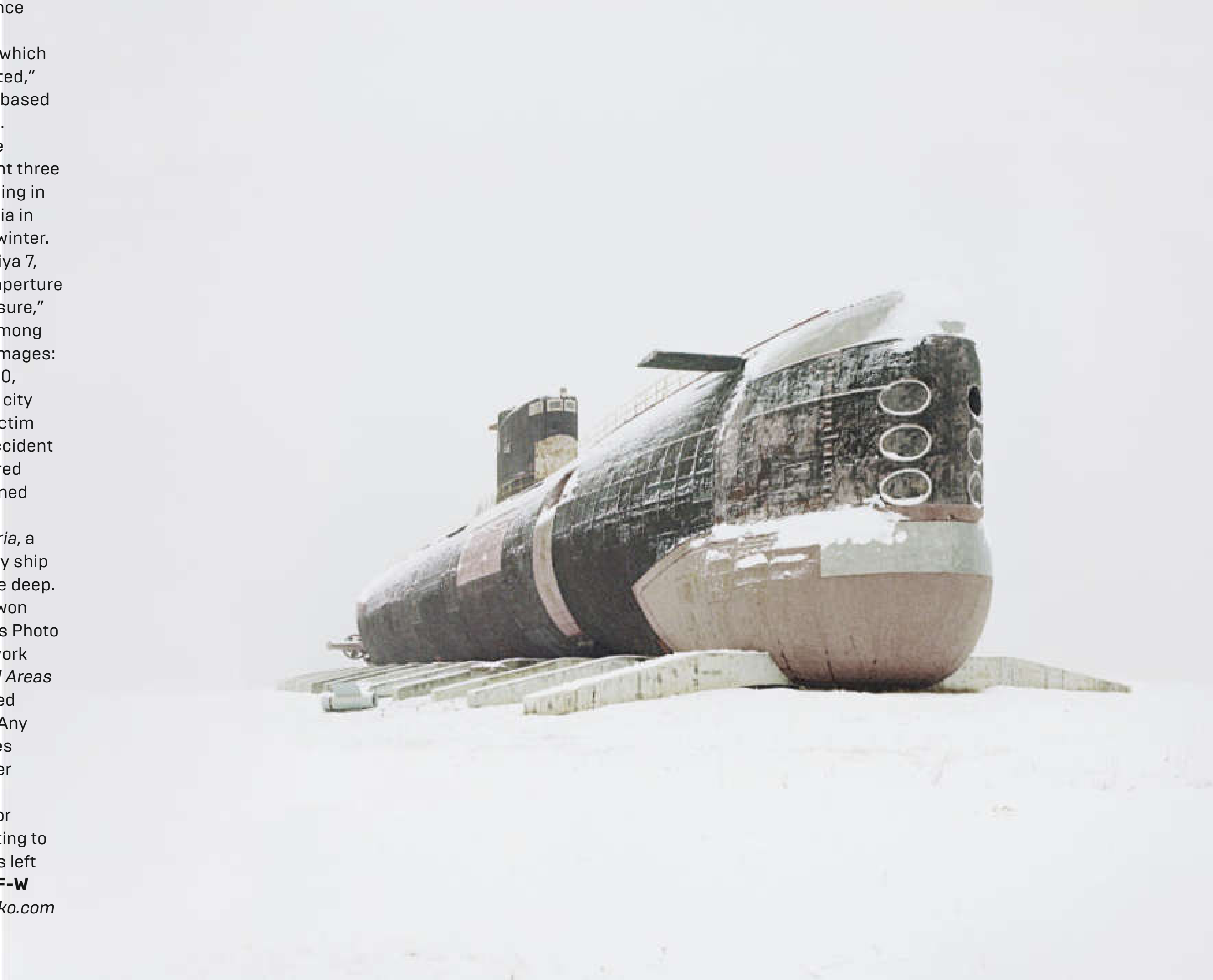
PHOTOJOURNALIST DANILA TKACHENKO HAS DOCUMENTED THE ABANDONED REMNANTS OF THE USSR'S MATERIEL, SPACE AND TECHNOLOGY PROGRAMMES

Once the symbol of Russia's Cold War military might, the Typhoon -class Russian diesel submarine (*pictured below*) now lies abandoned in the snow. The image is part of *Restricted Areas*, a series by Russian photographer Danila Tkachenko which shows lost relics of the USSR's materiel and technology programmes. "I travel in search of places which used to have great importance for technical progress, and which are now deserted," says Moscow-based Tkachenko, 25.

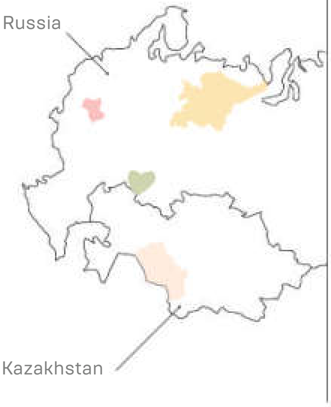
To shoot the series, he spent three months travelling in northern Russia in the depths of winter. "I used a Mamiya 7, with a closed aperture and long exposure," he explains. Among the haunting images: Chelyabinsk-40, an abandoned city site that fell victim to a nuclear accident that was covered up; an abandoned VVA14 plane; and the *Bulgaria*, a sunken military ship raised from the deep.

Tkachenko won the World Press Photo award for his work and *Restricted Areas* will be published in November. "Any progress comes to its end earlier or later," says Tkachenko. "For me it's interesting to witness what is left afterwards." **OF-W**

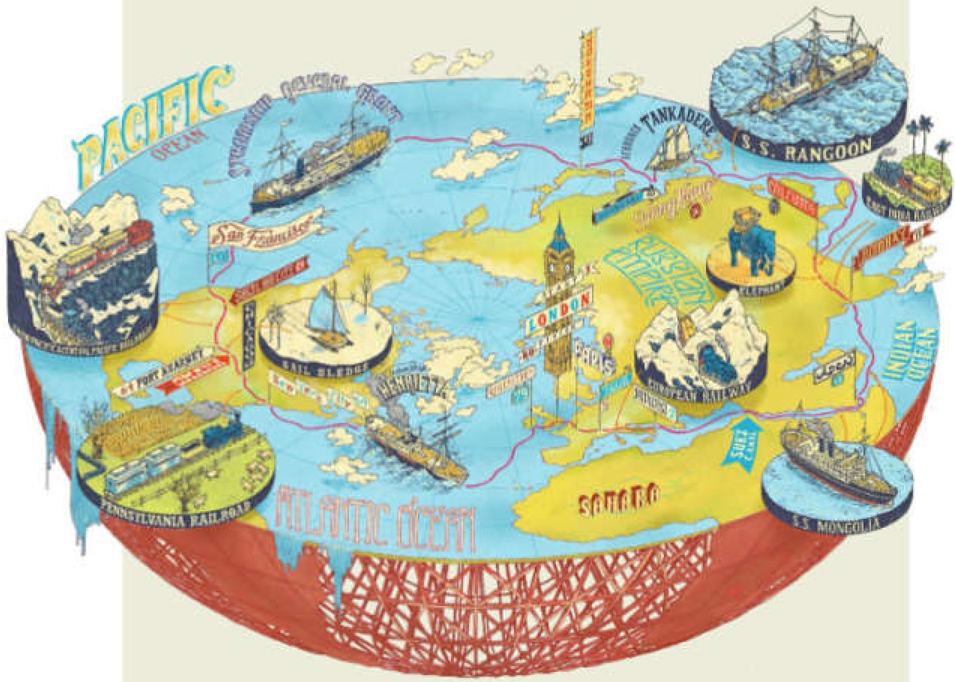
danilatkachenko.com



- 🟨 **Komi Republic**
  Former residential buildings in a polar scientific town specialising in biological research
- 🟥 **Moscow**
  One of only two VVA14 vertical take-off amphibious aircraft to be built by the USSR
- 🟩 **Samara Oblast**
  The world's largest diesel-run submarine lies in the snow
- 🟧 **Kyzylorda**
  Abandoned stages of USSR space rockets in what is now Kazakhstan



Andrew DeGraff's GPS representation of *Around the World in 80 Days*



TURN LEFT AT PAGE 88

ANDREW DEGRAFF HAS MAPPED 18 FAMOUS LITERARY JOURNEYS IN HIS NEW BOOK. BUT WHERE'S THE BALLOON?

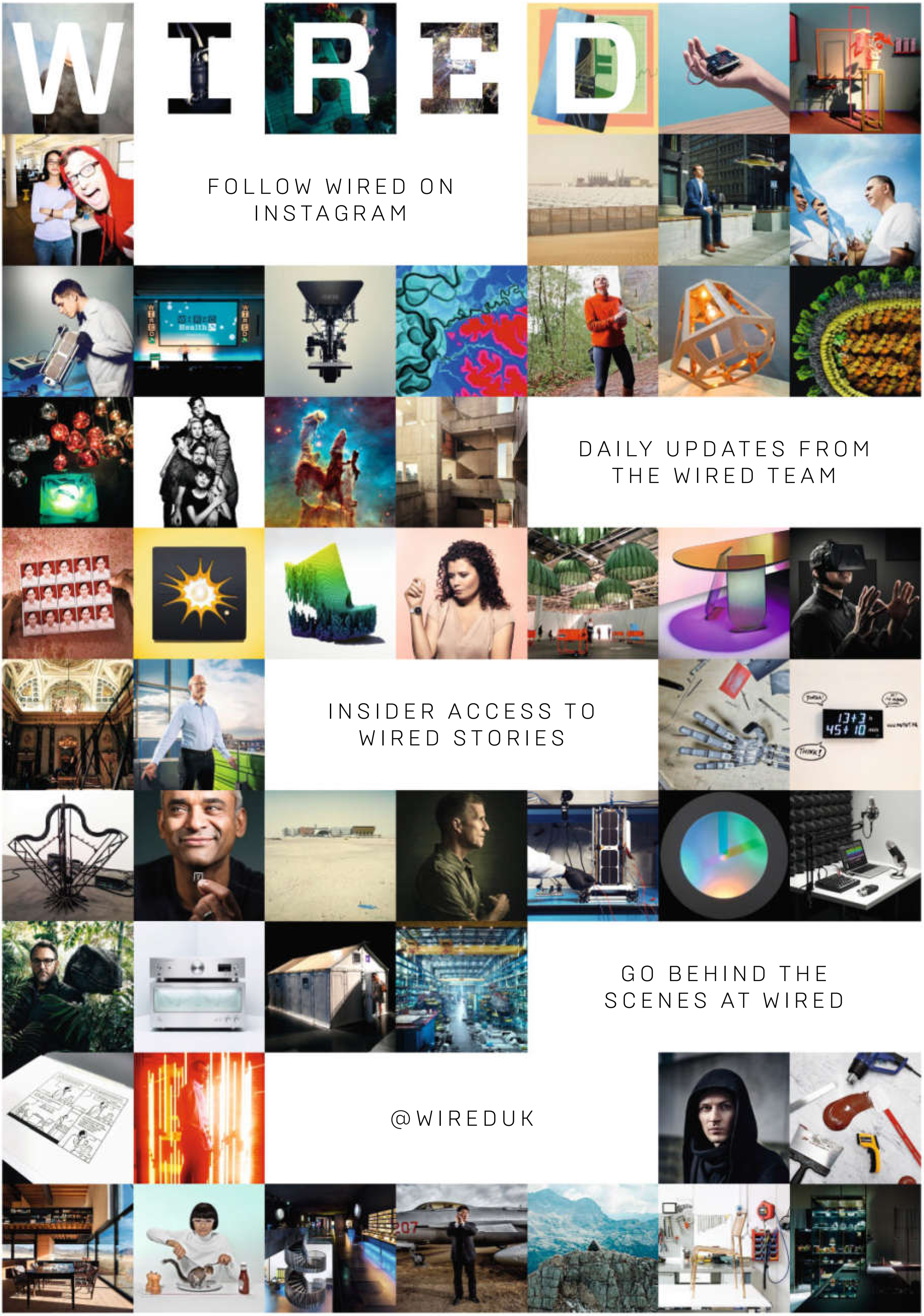
While mapping out the exact route that Phileas Fogg follows in *Around the* *World in 80 Days,* Andrew DeGraff had a revelation. "There's no balloon!" says the 37-year-old, California-based illustrator of Jules Verne's 1873 novel. "We think there is, but actually our memories have just been Disney-fied."

This map is among 18 cartographical takes on literary landscapes – a chapter-by-chapter visualisation of *A Christmas Carol*, for instance, and an Escher-like analysis of *Pride and Prejudice* – inside DeGraff's *Plotted: A Literary Atlas*. All of the titles he worked on had to fit his criteria of having some sort of scale. "To plot movement for a physically confined story such as *The Metamorphosis* would have become its own form of Kafkaesque nightmare," he says.

DeGraff's exhaustive research led to a bunch of illuminating lit-crit insights. For example, while researching Mark Twain's *The Adventures of Huckleberry Finn*, he combined every indicator of physical movement in the novel's 110,000+ words with real geography. "If Huck and Jim had travelled another 200 miles west, they would have found themselves in what the 1840 census called 'Unorganised Territory'," says DeGraff. Travel narratives, such as Huck's, proved the most fruitful, because "they can sprawl and languish to illustrate pace".

DeGraff hopes the maps can help introduce books to new readers, or refresh our memories of them. "Whenever I show these to people who have read the books there's an 'I totally forgot about that part' moment," he says. "It's fun to help fill in those holes." **Charlie Burton**
andrewdegraff.com Plotted: A Literary Atlas *(Zest Books) is out on November 1*

Digital extra!
Download the WIRED app to see more of DeGraff's visualisations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Black Coffee's house blend

THIS MAN BECAME A HIT DJ WITH ONE HAND. NOW HE WANTS TO TAKE ON ITUNES IN SOUTH AFRICA

Nkosinathi Maphumulo – aka Black Coffee – remembers the day fellow South African Nelson Mandela was released from prison. But for Maphumulo the memory is not a happy one: on February 11, 1990, crowd violence erupted in his town, Mthatha, and he dislocated his shoulder so badly that doctors considered amputation. Then 14 years old, he worried whether his dream career as a DJ would never happen. "The whole nation was excited but that for me was a terrible time," says the DJ/producer, now 39.

However, Maphumulo, who would sketch Technics SL-1200 turntables as a child, persevered. He ditched his physio, taught himself music-production software Cakewalk and, finally, got his dream turntables at the age of 22. But doubts about his mainly immobile arm remained. "I'd think to myself, 'How am I going to go through a crate of records, take a record out with one hand, play it and put it back in the paper thing?'" he recalls. Modern technology came to his aid: Maphumulo now uses a custom rig that includes bespoke Pioneer 350-CDJs with USB sticks, to mix with one hand. (He tends to place the hand of his damaged left arm in his pocket.) "Memory stick, memory stick dock, button, button," he explains. "It's much easier than it was previously."

Maphumulo's music as Black Coffee balances soulful live instrumentation with Logic-created house rhythms. He recently finished his new album, the first for influential dance label Ultra, due spring 2016. Maphumulo has also created *GongBox*, a retail app for South African music. Tracks cost 9.99 ZAR (50p). "You can't find South African music anywhere online," he says. "I couldn't even find my debut album there."

Persuading a nascent internet nation to buy MP3s – not to mention taking on Apple, Spotify and the pirates – may appear quite the challenge, but you wouldn't bet against Maphumulo. As Mandela himself put it: "It always seems impossible until it's done." **Andy Morris** *soundcloud.com/djblackcoffee*

Digital extra!
Download the WIRED app to listen to Black Coffee's music

PHOTOGRAPHY: NICK BOULTON

Artwork in the frame

THE BROAD MUSEUM'S VEIL PROTECTS ITS CONTENTS FROM TREMORS AND THE LA SUN

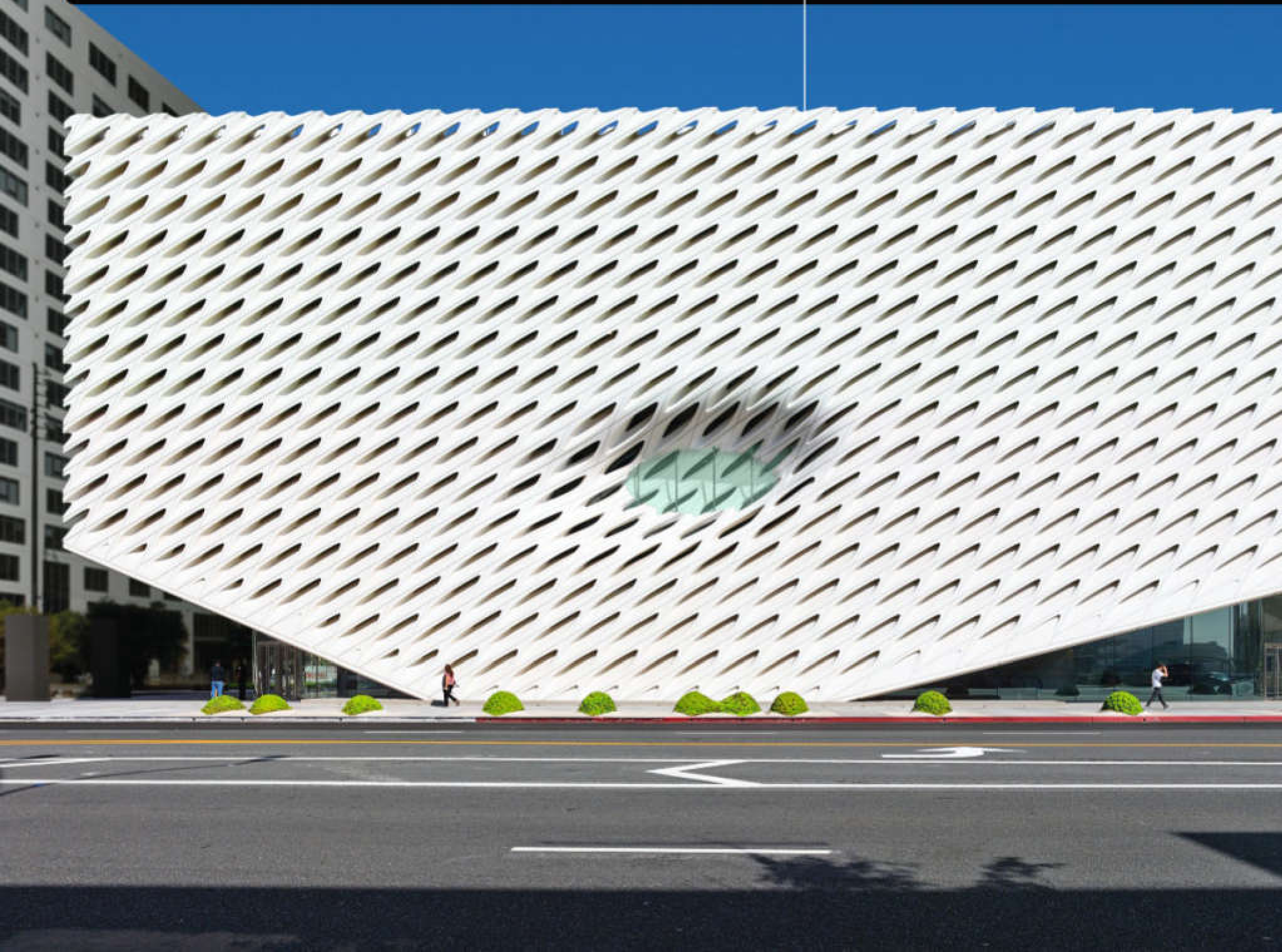
The tiny openings in this giant honeycomb structure may all look similar, but they actually comprise 300 different shapes. The glass-fibre reinforced-concrete (GFRC) veil engulfing The Broad art museum in Los Angeles is designed to diffuse light perfectly inside its gallery, keeping the use of electric lighting to a minimum whilst shielding the artwork from damaging direct sunlight.

Diller Scofidio + Renfro, the New York-based studio that designed The Broad, used Digital Project – the software used to design the Guggenheim Museum in Bilbao – to simulate the interplay between sunlight and the veil, and fine-tune the shape of its panels.

"The software allowed us to trace the Sun throughout the day, every day of the year, and through every single opening of the veil," explains Elizabeth Diller, the studio's principal architect. "We were able to see when there was any kind of transgression of light and fix it immediately." GFRC's matt quality and the position of the building – it faces north – also helped attain the intended light effect. "It's a kind of cinematographic feeling," says Diller, 60.

Too much or too little light wasn't the only threat to The Broad museum's art and visitors: in a city constantly worrying about "the Big One", the studio also had to put in place some solid anti-seismic measures. The solution: to design the veil and the

Digital extra!
Download the WIRED app to see more photos of The Broad museum



The veil, which includes 2,500 GFRC panels and 590 tonnes of steel, is supported at three points

PHOTOGRAPHY: IWAN BAAN; MAX OPPENHEIM. HAIR & MAKE-UP: CAROLINE SIMS

QUAKE-PROOF MUSEUM

main building (or vault) as two distinct elements. “Everything would move at a slightly different tempo,” Diller says. In the event of an earthquake, the veil is designed to rock independently, sliding on a 15-metre-long steel beam embedded in the pavement below to protect the rest of the structure from destructive vibrations. So while the building will inevitably be shaken at some point after its September reopening, the works of art inside should remain relatively unscathed. **Gian Volpicelli** *dsrny.com*

AN ENTREPRENEUR IN ESSENCE

Scent designer Lizzie Ostrom (*pictured*) wants you to think differently about smell. Odette Toilette, Ostrom’s London-based design firm, uses olfactory experiences to evoke reactions our other senses cannot – from reimagining paintings as perfume to exploring the subconscious through events and products. “A lot of my practice is about how to apply fragrance where it’s not normally used,” says Ostrom, 33.

Take ode, her device designed to help stimulate appetite for people with dementia through smell. “As dementia progresses, you see high instances of malnutrition,” she says. Like an alarm clock, ode emits hunger-stimulating scents around mealtimes. “Sweeter fragrances seem to be very good at stimulating appetite,” she says. “We did a test with 50 people, and over a ten-week period more than half of them put on weight.” The ode is now being used in care homes around the UK.

Self-taught in the art of scent-making, Ostrom insists she is not a parfumier. “I didn’t go to France and train for seven years,” she laughs. “I think of myself as an entrepreneur.”

Add author to the CV: on October 22 her first book, *Perfume: A Century of Scents*, is published by Henderson. “It’s a story about technology and innovations in the perfume industry, but also how lifestyles and cultures changed,” she says. She also recently worked with design studio Flying Object on *Tate Sensorium*, a multi-sensory installation at London’s Tate Britain museum.

Such high-profile projects, Ostrom says, illustrate the quiet revolution happening in the perfume world. “There’s been a huge growth in the indie or ‘scent designer’ scene,” she says. “Fragrance has been shrouded in mystery. My work is trying to help dispel that.” **OF-W** *odette toilette.com*

Lizzie Ostrom also co-hosts the acclaimed *Life in Scents* podcast

ONE MORE THING

If you'd like an in-depth discussion about algorithms or FaceTime, you should cross Aaron Sorkin off your list of conversation partners. But if you need an Oscar-winning screenwriter to elevate the tech world beyond the usual awkward-genius clichés, he is your man.

Though he swears that he has no idea how he became Hollywood's "go-to guy for the binary system", in the past five years alone Sorkin has won an Oscar for writing David Fincher's *The Social Network*, earned a second nomination (alongside Steven Zaillian and Stan Chervin) for Bennett Miller's *Moneyball* and churned out three seasons of the social-media-fuelled *The Newsroom*. Now, with *Steve Jobs*, the 54-year-old is daring to go where several writers have gone before – it's the latest in at least a dozen films about the late Apple co-founder (and the third to be released in 2015).

Staged as three acts – each taking place backstage at a major product launch (the Macintosh in 1984, NeXT in 1988 and the iMac in 1998) – the film is an adaptation of Walter Isaacson's comprehensive (and Jobs-authorised) biography. "Walter's biography had to be about what happened," Sorkin says. "It had to be a piece of journalism. When I write something, there is actually a requirement to be subjective; it's really the difference between a photograph and a painting." WIRED spoke to Sorkin about finding the balance between real life and entertainment in taking on a 21st-century icon.

In *Steve Jobs*, Oscar-winning screenwriter Aaron Sorkin takes us backstage to paint a painfully human portrait of the late Apple icon

How did your involvement in writing *Steve Jobs* begin?
Sorkin: I had just done *The Social Network* and *Moneyball* for Sony, with Scott Rudin producing. Amy Pascal, who at the time was the co-chairperson at Sony, called and said, "We want you to adapt Walter Isaacson's book." I sort of immediately began shaking. Scott is very good at talking me into things when I'm nervous about doing them and I said yes.

What made you so worried?
I'm nervous before I do anything. It's just standing at the bottom of a mountain and looking up with no clear path of how you're going to get to the top. But in this case, it was particularly daunting for me as I didn't know that much about Steve Jobs, and the idea of doing a biopic was daunting.

How did you get past that?
I work very slowly, and the first couple of months are spent just pacing around, climbing the walls, and saying, "I have no idea what I'm going to do. I don't know how to do this." It was in that period that I decided not to write a biopic.

Why not?
When you're making a biopic, it's very hard to shake the cradle-to-grave structure that audiences are so familiar with. People are going to come into the cinema knowing that first we're going to see a little boy with his father, and he's looking into the window of the electronics store, and then we're going to hit these famous signposts along the way in Steve Jobs's life. Also, I'm not really a screenwriter; I'm a playwright who pretends to be a screenwriter. I'm most comfortable writing in claustrophobic pieces of geography and periods of time. In reading about the trouble they were having getting the Mac to say "Hello" at the 1984 launch, I got this idea, and I wrote an email to Scott saying, "If I had no one to answer to, I would write this entire movie in three real-time scenes, and each would take place backstage before a particular product launch. I would identify five or six conflicts in Steve's life and have those conflicts play themselves out in these scenes backstage – in places where they didn't take place."

You've worked with him enough by now, though, that I imagine you've got his trust.
Really, I was emailing Scott to get help: take this thing that I really want to do and tell me what I'm allowed to do, because no studio is going to let me do this. Two or three minutes later, I got an email from Amy Pascal – Scott had forwarded my email to her – and she said, "I think this is a great idea." I couldn't believe it. They were going to let me do this thing. And so it turned into not a biopic. I'm not quite sure what to call it.

Did the fact that this and *The Social Network* could be construed as being similar give you pause at all?
Only the irony gave me pause – the irony being that I'm technologically illiterate. I'm not sure why I'm the go-to guy for the binary system, but I wasn't worried about repeating myself. I knew that it would be a different animal.

In the first trailers for the film, you really get that "Steve Jobs, rock star" vibe.
The big cheering crowd, yes. I was surprised, though, that there's actually not a lot of that in the movie itself. It all takes place backstage. I think there are people anticipating the movie's going to be just one big Champagne toast to Jobs. You saw it. It's not.

PHOTOGRAPHY: MICHAEL FRIBERG

If you were to tell me that Kim Jong-un was going to have a direct effect on my life, I wouldn't have believed you. But it happened. It really happened – while we were in the middle of casting *Steve Jobs*!

Walter Isaacson's biography is extremely comprehensive. How much did you rely on the text and the interviews in the book in crafting your script?
Obviously, Walter's book was invaluable. Also invaluable though was the time I spent with the actual people – with Steve Wozniak and Joanna Hoffman and several dozen others, but in particular with John Sculley and Steve's daughter, Lisa.

What surprised you most in reading the book and getting to know more about Jobs – the things that stuck out to you that you wanted to include?
There were two things that I wanted to try to get my arms around. One had to do with Lisa. I'm the father of a daughter too, and it was hard for me at first to get past Steve's treatment of his daughter – the denial of paternity and so forth. But what started out as this huge obstacle became a great engine for writing the movie, because Steve would find his way to being a father, which was great. The other thing is what we hear Seth Rogen say in the trailer: "What do you do?" Where is the evidence of genius from Steve Jobs? There's the success, I get that, but I'm not getting what it is that Steve did. It was in talking to Lee Clow and Woz and Andy Hertzfeld and all these people that I began to get an idea of it. But I also liked that question being asked.

Jobs was a big idea guy, but a lot of what we see in the film seems ego-driven.
The book *Steve Jobs* is a masterful piece of journalism. A movie can't be that. *Charlie Wilson's War*, with Mike Nichols, was the first non-fiction that I wrote, and there was this thing that Mike would repeat to me: "Art isn't about what happened." That sunk in. For as much as the movie is about one of the great tech icons, technology is really just a supporting character.

You describe yourself as technologically illiterate, yet with this movie and *The Social Network* and *Moneyball*, you seem to...
This isn't an origin story or an invention story. It's not about how the Mac was invented. And *The Social Network* wasn't about the tech that went into creating Facebook. But I knew that there was going to be no way I could write this movie without a lot of tutors. There are lines that I wrote in the movie that I don't understand.

There have been a number of other movies made about Steve Jobs, from *Pirates of Silicon Valley* to Alex Gibney's new documentary. Did you look at those movies at all to see what has already been done?
I haven't seen *Pirates of Silicon Valley*. By design, I did not see *Jobs*, the Ashton Kutcher movie, because I wanted to be able to say that I haven't seen it. But I rely on people who have seen those films to tell me if I just wrote a scene that was in another movie.

I don't know if you've noticed that many of the headlines talking about *Steve Jobs* refer to it as "Aaron Sorkin's *Steve Jobs*". Which is odd – and interesting – and must put some pressure on you.
In reality, of course, the movie belongs to a lot of people. Like [director] Danny Boyle. In failure, certainly, I'm going to blame Michael Fassbender.

Though he really is fantastic in the title role. Of course, it's quite public knowledge now that he wasn't the first actor cast in the role.
The truth of the matter is that *Steve Jobs*, comparatively speaking, went off without a hitch. I know it doesn't seem that way, primarily because of the Sony hack and then news leaking

After nearly a decade in television, Sorkin headed back to movies in 2007 by adapting the non-fiction book *Charlie Wilson's War*. That biographical path led to an Oscar for 2010's **The Social Network**, which told the story of Facebook's tumultuous birth. The following year, he brought Michael Lewis' best-seller **Moneyball** to the big screen, chronicling Billy Beane's data-driven efforts to turn the Oakland A's into baseball champions. Next up? Only the biggest tech icon of our age: **Steve Jobs**.

PHOTOGRAPHY: EVERETT COLLECTION; UNIVERSAL PICTURES

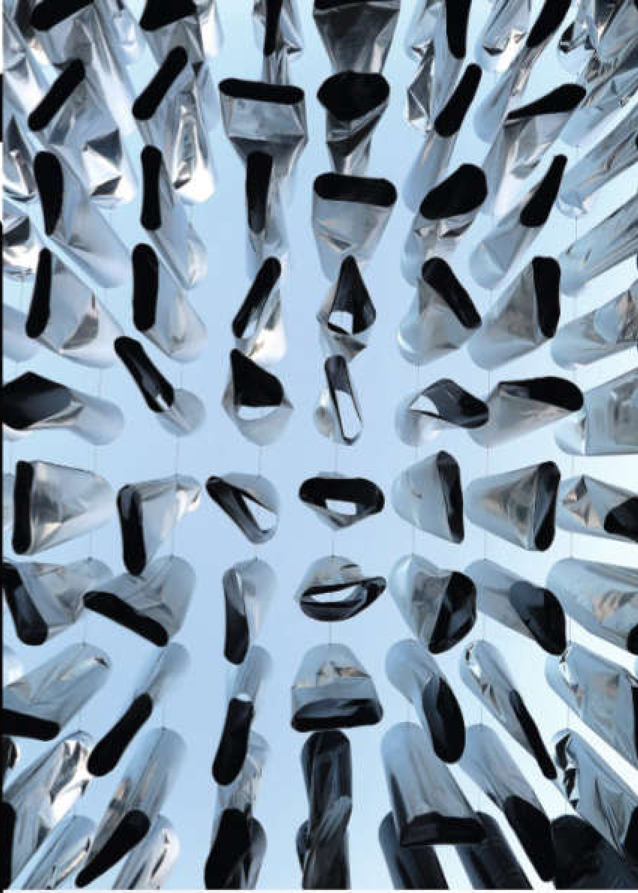
that we were talking to Leonardo DiCaprio and we were talking to Christian Bale.

As far as the Sony hack goes, you guys got off pretty easy – your movie certainly was not the main story there. But what does it feel like to wake up and learn that the whole of your communication about this movie you've been working on for years can now be read by anyone? The Sony hack was very troubling to me on a number of levels – I wrote about this in an op-ed for *The New York Times*. I couldn't get over the fact that news outlets were reprinting emails that had been stolen by extortionists who threatened the families of Sony employees. And to make matters worse, it happened to be North Korea.

And to think it was all kicked off by a Seth Rogen [who plays Steve Wozniak in *Steve Jobs*] comedy. Listen, if you were to tell me that Kim Jong-un was going to have a direct effect on my life, I wouldn't have believed you. But it really happened – while we were in the middle of casting *Steve Jobs*! We'd be having casting sessions over at Sony, and one day everybody got this really weird thing on their computer screen, this sort of upsetting imagery of skulls and blood, and then the next day it got worse. And then we watched the whole thing unfold in real time.

Did that change your habits? Are you sending more handwritten letters? Learning Morse code? I have a perhaps unhealthy stubborn streak in this area – I don't like altering my life because of bad people. But sometimes I won't be given the choice. When a movie is being rolled out, the studio publicists and all our individual publicists get together and come up with bullet points and talking points – "Make sure you stay away from this" and "Don't say that quite that way, because that quote can be taken out of context" and that kind of thing. The decision was made that none of those conversations can happen by email. They all have to happen over the phone. So there are things like that. The script itself was very heavily guarded. Once it was done, you had to go to Amy Pascal's or Scott Rudin's office to read it, and I'm talking about the heads of agencies – Ari Emanuel and Richard Lovett. An employee would be sitting in the room while they read it. There was just a lot of security around it.

How curious are you about the response? The film doesn't paint Steve Jobs in the most flattering light, and not everyone is going to expect – or want – that. There're going to be people who say we were rough on him and people who say we weren't rough enough on him. But I think we made a good movie, and if you asked ten writers to write ten movies about Steve Jobs, you'd get ten different movies that wouldn't resemble one another. **Jennifer M Wood** Steve Jobs *is out in cinemas November 13*



SOCIAL MEDIA'S ARTIST

Every Facebook status or tweet you post is just one of billions shared every day – but to Liat Segal it's art. "I'm interested in identity and our feeling of self in the context of social networks," says the Tel Aviv-based artist. "What we share fades away, but what if it was permanent?"

As an artist and hacker, Segal deals with the philosophical impacts of technology: how we shape our data, and how it shapes us. Take her 2014 show *People You May Know*. The title work is built from 76 speakers hung from the ceiling; each plays a recording of Segal reading out anonymous Facebook posts as the viewer walks underneath. *Placeholder* (*pictured above*) consists of nearly 1,000 foil tubes suspended two storeys up; only when viewed from a certain angle does the image – Facebook's female friend logo – reveal itself.

A computer scientist by training, Segal builds and codes each piece herself: *Writing Machine* consists of a paintbrush dipped in water and attached to a robotic arm above a plaster canvas; the arm writes the names of Segal's social-media contacts as they post. Other works, such as 2012's *Heart Of The Tin Man*, translate data feeds into abstract paintings. "I like to let the electronics show," she says. "For me, the cables are like painters: you can see the brushstrokes."

For her next show, in spring 2016, Segal will explore something even more complex: time. "I'm interested in the way time moves for people; like when 'time flies' or goes really slowly," she says. Slowing down, she says, might make us appreciate art in unexpected places – even on Facebook. **OF-W** *www.sweet-tech-studio.com*

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Compiled by Cleo McGee

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3 4

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WIRED INSIDER'S PICK OF UPCOMING EVENTS

WIRED NEXT GENERATION

Kids aged 12-18 (and their parents) can enjoy speakers and workshops at Tobacco Dock in London. Attendees will meet, among many others, YouTuber Thomas "TomSka" Ridgewell, who will be talking about his 3.6-million-subscriber vlog, and Matt Taylor, the European Space Agency scientist involved with the *Rosetta* mission, who will discuss space exploration.
October 17, 2015
wired.co.uk/nextgen

WIRED RETAIL

Returning for its third year, WIRED Retail is proud to announce speakers from Uber, Amazon, Stripe, Zalando and Ocado, are joined by experts in virtual reality, facial recognition, experiential retail, satellites and the blockchain. Taking place at London's St Pancras Renaissance Hotel, WIRED Retail will give delegates an entirely new perspective on commerce.
November 19, 2015
wired.co.uk/retail15

AI WEIWEI AND WIRED

Internationally renowned artist Ai Weiwei is exhibiting at London's Royal Academy of Art from September to December. The RA have set up a lates series – and WIRED is partnering with them for Ai Weiwei's show, for one night only. Looking at his use of the internet, we will focus on the possibilities, promises and treacheries of digital technologies, via interactive exhibits and insightful talks.
October 24, 2015
royalacademy.org.uk

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@WIREDINSIDERUK

PHOTOGRAPHY: SUN LEE

SOCIAL CLUB 2.0

BIG ON YOUTUBE? SO 2014... THE NEXT MEDIA STARS ARE VINERS AND TWITCHERS.

The YouTubers are taking over. From Zoe Sugg to Tanya Burr, Alfie Deyes to ThatcherJoe, social-media stars (and, in some cases, their ghostwriters) are churning out novels, memoirs and comic books this month, confident that their millions of subscribers will get them on the bestseller lists. But to find out who'll be big in social content next year, look beyond YouTube: the next generation of stars is building fanbases (and generating cash) on *Snapchat*, *Vine* and elsewhere. Here's WIRED's guide to the next Zoellas. GV

Lele Pons

Vine

Miami-based Eleonora Pons, 19, was not a social-media enthusiast. But that changed when she discovered *Vine*. Her six-second clips of sketches and jokes have helped her amass more than nine million followers, and a flurry of internet accolades.

Brian Wyllie

Twitch

Canadian Wyllie, 26, spends up to ten hours live-streaming his video-gaming sessions on the platform. Since 2011, he has attracted more than 800,000 followers and 185 million views. Of course, it has its other rewards: "I've earned enough to be well off for the next ten years," he says.

Sallia Goldstein

Snapchat

Sallia Goldstein uses *Snapchat* to turn her life into a cartoon. The 24-year-old trained engineer is also a big advocate of science. "I would love to encourage my *Snapchat* audience to pursue STEM (science, technology, engineering and maths)," she says.

EvanTubeHD

YouTube

EvanTubeHD wasn't even born when YouTube was founded in 2005, but since his dad Jared started uploading reviews of toys in 2011, their channel has picked up almost two million subscribers. The pair claim it generates about $1.3 million a year.

Amanda Oleander

Periscope

Amanda Oleander, 25, downloaded live-streaming app *Periscope* two days after its release in May 2015. By July, the Los Angeles-based artist had amassed 34 million hearts (*Periscope*'s version of likes) and now 300,000-plus followers watch her marathon online sessions.

Taylor Nikolai

Snapchat

Nikolai, 27, used to be big on YouTube, but the real success arrived when he launched @WTFfacts, his *Snapchat* channel. "I've been invited to all sorts of events that I never would have been invited to otherwise," he says. "I've even begun to get cast in movies."

Kyle Landry

Twitch

Based in Boston, US, Kyle Landry moved to *Twitch* this year after having made a name for himself on YouTube. Since then, his live-streamed piano sessions have attracted millions of views. Improvisation is his speciality: "Everything comes from the top of my head," he says.

Jérôme Jarre

Snapchat, Vine

YouTube mid-size celebrity, *Vine* grandee (8.5 million followers) and *Snapchat* star Jérôme Jarre has effectively transformed his social-media talent into a job. A Frenchman based in New York City, the 25-year-old is also a talent agent for up-and-coming social-media stars.

ILLUSTRATION: ALEC DOHERTY, PHOTOGRAPHY: GETTY

Hollywood gets real

NEVER MIND THE GIMMICKS: A WAVE OF FILM-MAKERS ARE TURNING VR INTO A NEW FORM OF STORYTELLING

There's a scene in Gabo Arora and Chris Milk's virtual reality documentary *Waves of Grace* when you find yourself standing over a Liberian grave as volunteers in hazmat suits lower another victim of the Ebola virus into the ground (*pictured*). Being in VR, you feel like you could topple into the hole; and when you turn to see hundreds of marked graves around you, the reality of life in the disease-ravaged country hits you harder than any news report ever could.

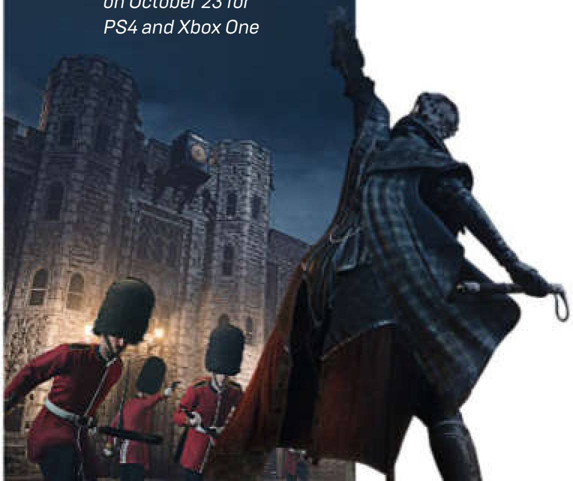
"VR allows you to truly take someone there," says Patrick Milling Smith, co-founder of Vrse.works, the LA-based production company that created the film in partnership with the United Nations. "You can literally make someone feel like they have been teleported to a destination. When someone looks into your eyes, it results in a connection that is only possible in virtual reality."

ASSASSIN IN THE SMOKE

Ubisoft's *Assassin's* *Creed* franchise has let players climb, leap and stab their way across history's most famous buildings. This month's *Assassin's Creed Syndicate* brings the series to Victorian London, where the capital's architecture proved to be a gift for its free-climbing gameplay. "If I was in good shape, I could climb Westminster Abbey," says Jonathan Dumont, world designer for the game.

Assassin's Creed Syndicate players can switch between sibling assassins Jacob and Evie Frye to battle the Templar-riddled establishment – from wealthy Westminster to the East End slums. A few liberties had to be taken: Whitechapel has moved north and west, and the South Bank got an industrial makeover. "In 1868 that side of the Thames was mostly warehouses," Dumont says. "Industry was further down south, so we brought that more into Southwark."

Historian Jean-Vincent Roy sat with the team in Québec and brought in Victorian specialists, including novelist Judith Flanders, to add some accurate details. "[Roy] came up with cool stuff," says Dumont. "A poverty map from 1870, sewer plans, even reminders of the importance of omnibuses." **Daniel Nye-Griffiths** Assassins Creed Syndicate *is out on October 23 for PS4 and Xbox One*



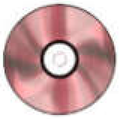
CHARTED

WELCOME TO THE FUTURE

October 21, 2015, is the day to which Marty McFly time-travels in *Back to the Future Part II*. But which of the film's predictions have come true?

Auto-lacing trainers
Nike announced that it will release a pair later this year.
Accuracy 5/5

Hoverboards
Prototypes have been tested, but they require a conductive metal riding surface.
Accuracy 3/5



LaserDiscs
It's not that the format flopped – physical media just looks so, um, 80s...
Accuracy 0/5

With the arrival of consumer VR headsets, starting in October with the HTC Vive and continuing in March 2016 with the Oculus Rift, virtual reality cinema is about to explode (see our forthcoming WIRED *World in 2016*). The form has also led to a flurry of studios adopting the new form of film-making. *Henry*, the second animated film from Oculus Story Studio, features an affection-starved hedgehog that reacts to your gaze in real time. *First Life*, created by London-based Atlantic Productions, is the first VR nature documentary, complete with narration by David Attenborough.

London-based Unit9 has made VR shorts for the likes of Lexus and Stella Artois. "We are establishing the language and conventions of a new form of storytelling," says creative director Henry Cowling, 35. "Right now, every project we create is charting new territory, whether technically or creatively." Many early films often focus on sheer sensation; putting you inside the head of a world-class footballer or an aerobatics pilot. (Some startups, such as Somniacs and Hyve, have gone even further, building full-blown simulators with air fans and added smells to heighten the experience.)

But the medium can also have much subtler effects – such as heightening our sense of empathy. "It's an incredibly intimate and often emotional experience," says Rewind studio founder Solomon Rogers, 35. "When we showed our Björk music video [for "Stonemilker"] at MoMA in New York, we had people in tears because they were so moved by what they had seen and felt."

It's innovative storytelling like *Waves of Grace* – rather than disorientating marketing stunts – that will ensure a life for VR beyond launch. "The medium is moving at lightning speed," says Vrse.works' Milling Smith. "But you only need to witness people's reactions [to VR] to realise this is going to have a profound impact." **OF-W**

PHOTOGRAPHY: EMILY SHAW

FIVE VR FILMS YOU NEED TO SEE

Clouds Over Sidra
The first UN documentary by Gabo Arora and Chris Milk follows Sidra, a 12-year-old Syrian refugee. The VRSE app is available on iTunes. *vrse.com*

First Life
Narrated by David Attenborough, this takes you to the ocean floor 500 million years ago. At the Natural History Museum in London. *nhm.ac.uk*

Stonemilker
Created by Rewind for Björk's recent MoMA exhibit, the video, on an Icelandic beach, shows the power of binaural sound (and multiple Björks). *youtube.com*

Henry
The second film from Oculus Story Studio, this animated short by a former Pixar director follows a friendly hedgehog. Requires Oculus Rift. *oculus.com*

Birdly
Less a film than an experience, *Birdly* straps you to a bird-like simulator (with fan-made wind) to fly over San Francisco. *somniacs.co*

CAMERAS ROLLING, HELICOPTER ROLLING

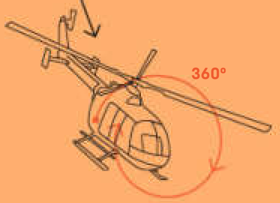
GARY POWELL MAKES PRACTICAL STUNTS POSSIBLE FOR BOND

Gary Powell has the kind of job that kids fantasise about. When James Bond needs to drive a tank through a city, flip an Aston Martin over or crash a plane in Her Majesty's (secret) service, it's to Powell, the film franchise's stunt co-ordinator, that the film-makers turn. "I've always been of the view that if you can do it for real, then do it for real," says Powell, 51.

It's May 2015, and WIRED is on a night shoot for *Spectre*, the 24th James Bond film and the fourth outing for Daniel Craig. A Jaguar and a Ford SUV smash into each other at high speed. The wreckage is brutal, but both drivers emerge unscathed – the cars have been modded with fuel cells, gel batteries, hidden roll cages and harnesses. "Anything the cast has to go in, I'll put myself or one of the guys in, to make sure it is safe," says Powell. "That means we get to play with all the toys first."

Powell has worked on Bond productions since 1995's *GoldenEye*. "In that film I was driving a tank," he says. "I had a police escort as I was doing 65kph through the centre of St Petersburg." Each new film presents its unique challenges: among those for *Spectre*, a fight scene on a helicopter just a metre or so above a crowd of extras in Mexico City, the sequence included an in-air barrel roll (*above*). There was also a chase sequence that required crashing a twin-propeller Britten-Norman aeroplane into an Austrian mountainside. "You always want to better yourself, but it has to make sense in the story," says Powell. "It's not just 'Let's do a massive explosion for the sake of it.'" For the sequence, a plane was suspended from two cranes; the crew also deployed 50,000m^2 of fake snow. "We were 3,000 metres up, 150cm deep in the snow," says Powell. "Each stunt has its own challenges and its own danger." (Days earlier, two stuntmen were injured filming another scene.) After sliding the plane down the mountain, the crew built a cannon to fire the plane chassis through a purpose-built wooden cabin, built just for the shot.

Such visceral scenes, Powell says, illustrate both the risks and the rewards of pulling off practical effects in an age of CGI. "It'll look amazing," he says, "It looks real because it is real. But most importantly, everyone is safe." **OF-W** Spectre *is out on October 26*



Above: The *Spectre* helicopter stunt sequence was shot in Zócalo Square, Mexico City

ILLUSTRATION: ALEXANDER WELLS

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ustwo co-founders John Sinclair (*left*) and Matt Miller in their London office

UNCANNY VALLEY

HOW THE LONDON-BASED TEAM BEHIND MONUMENT VALLEY TURNS DESIGN INTO ART

Matt Miller, co-founder of London-based design studio ustwo, fired off an email to the team working on iOS and Android game *Monument Valley* back in 2013. It included objectives both concrete (iPad game of the year "at the very least"; minimum 200,000 sales) and abstract: it should "make you cry" and "be the type of art you need to put on your wall".

His demands paid off: *Monument Valley* has racked up four million downloads since its release in April 2014 (and yes, it did win Apple's Game of the Year). The puzzler, which challenges players to help Princess Ida navigate tricky mazes, was beta-tested by non-gamers at ustwo, who made suggestions, such as making the game shorter. "We wanted it to be like an album," says Miller. "Who gets to finish things nowadays? Nobody ever finishes *Candy Crush*."

With 250 staff across four offices, Miller and co-founder John Sinclair divide their focus between risk-taking projects such as *Monument Valley* and commissions for the likes of Sony and Tesco. The follow-up to *Monument Valley*, *Land's End*, is being developed for Samsung's Gear VR. Meanwhile, Miller and Sinclair are overseeing *Wayfindr*, an audio-driven app to help blind people navigate the London Underground, and DICE, a ticket-selling venture part-funded by the founders of Google's AI startup DeepMind (WIRED 07.15). "We're not trying to do the same thing over and over again," says Miller. "When you give very talented people the space and the freedom to do something, they will do it."

Daniel Nye Griffiths *ustwo.com*

THREE FROM USTWO

Monument Valley's Escher-inspired design won Apple's Game of the Year

Land's End applies the artistic style of *Monument Valley* to virtual reality

Moodnotes, a mental-health app, is designed around principles of CBT

PHOTOGRAPHY: JAY BROOKS

BEAT THE AUTUMN BLUES WITH THE GORE-TEX® EXPERIENCE TOUR. THIS IS YOUR CHANCE TO WIN A ONCE IN A LIFETIME SURF AND SNOW TRIP, AND CONQUER NORWAY'S DEEPEST FJORDS AND HIGHEST MOUNTAINS

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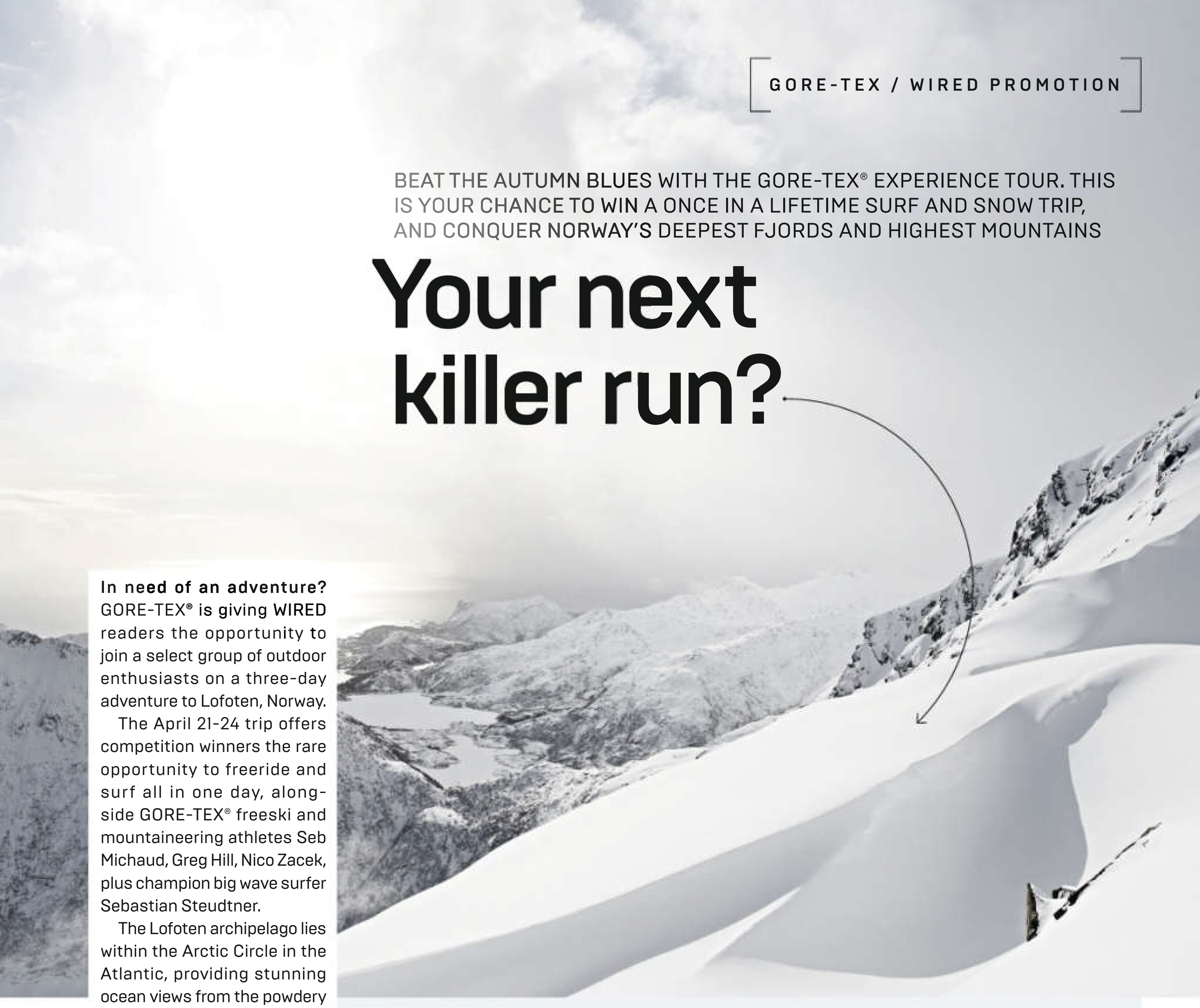

In need of an adventure? GORE-TEX® is giving WIRED readers the opportunity to join a select group of outdoor enthusiasts on a three-day adventure to Lofoten, Norway.

The April 21-24 trip offers competition winners the rare opportunity to freeride and surf all in one day, alongside GORE-TEX® freeski and mountaineering athletes Seb Michaud, Greg Hill, Nico Zacek, plus champion big wave surfer Sebastian Steudtner.

The Lofoten archipelago lies within the Arctic Circle in the Atlantic, providing stunning ocean views from the powdery slopes and some astonishing surfing waters. Attendees will be kitted out with the latest in GORE-TEX® products – including its new GORE® C-KNIT™ range, which is lighter, more breathable and softer than comparable previous products.

HOW TO WIN

You can apply for the GORE-TEX® Experience Tour from October 1 to December 31, 2015. Simply follow the link below to find out how to enter and be in with a chance of visiting Lofoten. Experienced skiers and snowboarders are welcome, but being a skilled surfer is not a requirement. Winners will be selected by a jury and announced in February 2016. ***To enter, visit wired.co.uk/wired-insider/2015/gore***

YOUR GORE-TEX MOUNTAIN GUIDES

SEB MICHAUD – FREESKIER

•

Michaud skied at the age of three. He now counts the Red Bull Snowthrill and the O'Neill X-treme as career highlights. "Skiing is not only my job, I feel great when I'm on the mountain," he says. "The elements are around you and you play with them. Whether contest, shooting or free sessions with friends."

SEBASTIAN STEUDNER BIG WAVE SURFER

•

Steudner is at home on waves some 20 metres high, travelling at up to 80kph. He ranks as the greatest German big wave surfer of all time. "Germany is landlocked and it's six hours to the nearest oceans," he says. "In order to do anything in surfing, you have to get out of there and I knew Hawaii was the place [to] surf."

GREG HILL MOUNTAINEER

•

In 2010, Hill tackled over 600,000 metres of climbs in 266 days. He was the first North American to scale Mont Blanc within 24 hours with skis and a harness. "Ski-mountaineering is a place where you can explore your own limits," he says. "There are endless mountains and endless places to explore."

NICO ZACEK – FREESKI PRO

•

In his 14 years as a pro skier, Zacek has won numerous international competitions. He has created an extreme sports and photography series called Nine Knights. "For me it's one of the most interesting and creative sports out there. And we're in the mountains – which is just beautiful."

Playlist

▶ DON'T LOOK DOWN

Philippe Petit's historic tightrope walk between New York's Twin Towers is the subject of Robert Zemeckis's latest film *The Walk*. Thankfully, Atomic Fiction studio's VFX allowed the steps to be replicated on solid ground. *Out on October 9*

▲ A PINCH OF SALT

Roseau's debut album *Salt* comes after the British multi-instrumentalist's early tracks were breakout hits on YouTube and Spotify, earning features in *Grey's Anatomy* and *Adulthood*. Think electronic atmospheres with jazz influences. *bigdada.com*

◀ MASTER CHIEF RETURNS

Halo 5: Guardians, The latest chapter of Microsoft's first-person shooter, has already shed new light on protagonist Master Chief – and with a Spielberg-produced series in the pipeline the plot can only thicken. *Released on October 27*

▲ THE ART OF MOURNING

Cartoonist and *New Yorker* illustrator Adrian Tomine began his Optic Nerve series in 1991. Twenty-four years later, the stories in his new collection, *Killing and Dying*, deal beautifully with death, family and stand-up comedy. *Out on October 6*

▼ ANGER MANAGEMENT

Monster reboot alert: ITV's take on the shapeshifting Dr Jekyll is set in the 1930s. *Jekyll & Hyde* follows Jekyll's grandson as he experiments with his family's super-serums [they never learn]. An art-deco take on a sci-fi classic. *From this month*

◀ LIFE-INSPIRED ART

From sculptures hewn by biomimetic algorithms to pictures grown in a Petri dish, William Myers' book *Bio Art* profiles some of the artists exploring the area where natural science and creative industries meet. Lively. *Out on October 12*

PHOTOGRAPHY: VINCENT FOURNIER, POST NATURAL HISTORY: BROWN-CHEEKED HORNBILL [BYCANISTES ATTRACTIVUS] WITH UNBREAKABLE BEAK, 2012 – ONGOING

THE TT COLLECTION

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When the game is real

A LONDON-BASED APP DEVELOPER IS WORKING TO ERODE THE DISTINCTION BETWEEN REALITY AND GAMING, ALLOWING ITS PLAYERS TO TRADE FINANCIAL MARKETS FOR FUN – AND WIN FOR REAL

The financial markets are the biggest, greatest game of humankind," says Kerem Ozelli. Now he wants everyone to play them. Ozelli is founder of *Flick a Trade*, a trading app based on real-time market changes. On iOS and Android devices, players can bet virtual currency or play for money in three game modes: solo, one-to-one, and multi-player.

For Ozelli (*above*) the concept of "reality gaming" has been 27 years in the making. Since the late 90s he worked in the financial industry in the US, Asia and Latin America, building and running sale and trading platforms for the likes of Credit Suisse, ABN Amro, Société Générale, Deutsche Bank and CMC Markets. But, after 30 years in the business, he became disenchanted with the "creatively hollow" industry. Instead

+210k
Downloads of *Flick a Trade*

11 mins
Average session duration

$1.2bn
Daily notional value of transactions

PHOTOGRAPHY: NICK WILSON

Ozelli became interested in the vast numbers of people playing mobile and online games such as *Farmville*, *Clash of Clans* and *Candy Crush*, as well as simulation, strategy and gambling apps.

"I thought: wouldn't it be amazing to get the kinds of engagement you see in gaming and gambling, but in finance?"

The answer was to simplify trading to its core elements, remove the complexity and gamify the experience. After three years of self-funded development, design and beta testing, *Flick a Trade* launched with real money in June 2015.

The gameplay – swipe up to predict a market's rise, down to predict a downturn – means even a novice has a 50 per cent chance of being right in solo mode.

Such simplicity is one of the ways the team has sought to remove the dangers of playing the markets. Others include time limits to each session – from one minute to 24 hours – because in finance "a lot of nasty things happen overnight."

Stakes are currently limited to £1,000, which is broken down into 20 smaller up/down bets, making it tricky to lose big. The game format also tames the toxic characteristics of leverage – the ability to get in debt to increase potential winnings, as well as losses.

Shortly after launch, players began asking why live financial markets were closed during weekends. So, the team developed a set of fictional commodities with live-streaming prices such as Kryptonite, Explodium and Acoustium. Powered by a randomised engine, which has been tested and certified by The Gaming Commission, these markets act just like real markets with respective rallies, crashes and peaks.

In the UK – the only territory where you can currently put real money on the line – the app is regulated by the Gambling Commission. But Ozelli plans to bring the full game to Europe soon, with further ambitions to expand into the US and Asia. "These markets are a no-brainer for us," says Ozelli, pointing to the recent success of *FanDuel* and *DraftKings* – games of both chance and skill. That's no surprise – the team behind *Flick a Trade* is skilled, experienced and ambitious. CIO Harald Fresacher developed a pioneering web-based financial information system in the late 90s and a social trading game in 2004. Mario Hoepfner, head of mobile, developed one of the first location-based taxi apps. Saro Gragossian, Helmut Ellersdorfer and Hannes Kaiser created the first mission critical, cloud based, trading and gaming engine.

The game's data is already showing some interesting patterns. Competition is key, and relative performance is a very meaningful measure of success. "From the performance stats, we see people becoming better *Flick a Trader*s all the time," Ozelli says. The more they play, the better they get – from spotting trends and hot markets to mastering an array of strategies for pulling high scores. Let's find out. ***flickatrade.com***

HOW TO FLICK AND WIN

Ways to play

Flick a Trade is a game of chance and skill. It is the first real mobile and social trading game which has simplified the markets into a time-bound, limited risk game. With the option to use real or virtual currency, players may choose from three different gameplays: go solo in Single Player, challenge an opponent in Head to Head, or try to beat the crowd in Multiplayer mode. Zoom out to spot the trends, flick up to buy and flick down to sell.

Single Player

In Single Player mode, gamers go against the market. First, set your trading duration, then place your stake. You can diversify your chances by trading on up to 20 different markets in any one direction – using gains in one to absorb losses in another. Single Player mode also lets you create and manage multiple portfolios and custom watch-lists, set alerts, and cash out at any time.

Head to Head mode

The Head to Head mode enables exciting one-to-one games with an opponent, where you compete for the highest score. Whoever makes the highest profit wins the game – and takes all. You can play Head to Head instantly – with the game automatically matching players via the cloud – or you can create your own private one-to-one games by challenging a friend through your contact list or via Facebook, Twitter, SMS or e-mail.

Multiplayer mode

Use Multiplayer mode to try to beat the crowd in a bid to reach the top of the leader board by outperforming other players. Players can join daily Multiplayer games with a variety of entry fees and respective prize pools, or create custom games with friends and family. During each game players try to maximise profits, with this being their overall score. At the end of the game, the top scores on the leader board earn a scaled share of the prize pool.

INSIDER

Events, new products and promotions to live the WIRED life

Compiled by Cleo McGee

1 2
3 4

1/Ardbeg Uigeadail and Supernova

Peated to more than 100 parts per million, Supernova is the peatiest Ardbeg ever and quite simply a heavenly whisky. For something more subtle, try Ardbeg Uigeadail (say it "oog-a-dal"). Its special vatting marries Ardbeg's deep, smoky notes with luscious, raisiny tones. ***Supernova £125; Uigeadail £61 ardbeg.com***

2/Peak Performance Gore-Tex special edition range

This limited collection of outerwear is aimed at the serious skier who wants the best of the best for all-mountain use. Made with Gore-Tex to provide protection against wind, rain, snow and the elements, this range provides both style and substance in abundance. ***Jacket £poa peakperformance.com***

3/Ettinger Pursuits Olive and Havana Cotswold bag

This handsome weekend bag is made from a sturdy olive cotton drill (other colours available) and trimmed in a waxy hide. Inside, a generous internal compartment takes plenty of travel essentials, while two practical slip-pockets hold smaller items. Carry by handle or shoulder strap. ***£625 ettinger.co.uk***

4/Knomo Dale totepack in green leather

Knomo's leather Dale "totepack" blends functionality and style. It features a shockproof laptop holder, a Knomad-inspired organiser, a front zipped pocket and storable shoulder straps. Any synthetic parts are made using recycled PET from old plastic bottles. ***£tbc knomo.com***

WIRED INSIDER'S PICK OF UPCOMING EVENTS

WIRED 2015

WIRED's flagship annual two-day event returns this October 15-16, taking place once again at Tobacco Dock in London. Speakers range from Arunima Sinha – the world's first female amputee to climb both Mount Everest and Mount Kilimanjaro, to Hyeonseo Lee, a North-Korean defector and activist, to Misha Glenny – global-crime investigator, and Renè Redzepi, co-founder of the pioneering Noma restaurant. Besides the talks, the WIRED Lab will be back with the most exciting new products – and the networking opportunities will, of course, be second to none. Unmissable. *October 15-16, 2015 wired.co.uk/15*

SONOS STUDIO

Sonos Studio London in Shoreditch is a social, collaborative space connecting artists and audiences through music, art and technology. Following the launch of Sonos Studio Los Angeles, Sonos Studio London arrives in September. The two-storey warehouse will boast a concert space, listening rooms, work stations and a café – as well as an ever-evolving creative programme of events and exhibitions. Sonos Studio is Sonos' lens on music, art and technology, and epitomises a commitment to the capital's community of creatives. *Sonos Studio London, 21 Club Row, London E2 7EY studio.sonos.com*

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PHOTOGRAPHY: SUN LEE

HOW TO

ILLUSTRATION: MARC ASPINALL

How to...

ASSEMBLE A FIRST-PERSON-VIEW DRONE

You mean you still haven't flown your own UAV? Systems engineer Dave Shevett, who has flown remote-controlled gliders and aeroplanes, and built his own racing car, decided to make his own remotely-operated quadcopter after seeing an incredible first-person-view (FPV) quadcopter-racing video on YouTube. Here's how to do it. Be sure to check the Civil Aviation Authority's drone code, though, to keep you out of trouble... **Jeremy Cook** >

1 GATHER THE DRONE PARTS

You'll need a frame. Shevett decided to go with a 250mm model, the diagonal distance between motor centres. You'll also need four motors and propellers, a flight controller (FC; he used a CC3D from OpenPilot) and four electronic speed controllers (ESCs). These can be purchased as a kit or separately. Also, you'll need a lithium polymer (LiPo) battery, a power-distribution board and, depending on the requirements, a 5V regulated power supply for your FPV camera and other things. A common battery size is 1300mAh; too large and it will be too heavy to take off. Finally, you'll need straps and zip ties to keep it all in place.

2 ASSEMBLE THE CONTROLLER

To control the quadcopter, you'll need a handheld transmitter (TX) and a radio signal receiver unit (RX) attached inside the drone. Shevett uses a FlySky FS-T6 transmitter and FS-R6 receiver. The RX is wired to the FC unit, which commands the motors via the ESCs. FPV hardware is fairly simple, comprising a camera and video transmitter on the drone and a receiver and display on the ground. He uses a Fatshark 600TVL camera with a 5.8GHz 250mw transmitter, powered by the 5V power supply. He uses 5.8GHz radio frequency Fatshark goggles to receive and display the signal.

3 BUILD THE FRAME

Shevett's kit consisted of two layers of carbon fibre that were attached together with Allen screws and standoffs. It's a basic kit assembly, so you have a frame in your hands that looks like a drone, but without the wiring or motors. "It only takes about two hours," he says. "Adding motors, wiring, radios, however, can take weeks." Motors are generally attached with Allen screws as well. Install propellers on each motor (to be removed before testing); two will need to use clockwise propellers (front-left and back-right), and the other two anti-clockwise propellers.

4 WIRE THE MOTORS

Starting with your LiPo, hook up each of your ESCs so that the red wire goes to the positive battery wire, and the black to the negative. Each is powered in parallel, so the red and black from the battery can be connected to four separate wires to power each ESC. This can be done by soldering, but connectors are available to make this easier. The other end of each ESC will have three connections that are hooked to the three wires of each motor. Unlike the connections from the battery, accurate wiring is not critical – it simply determines which way the motor spins. If one or more motors spins backwards, flip any two wires.

5 CONFIGURE THE CONTROLS

Connect each of the ESCs to the flight control board using a three-wire connector, then plug the connectors from the FC into the RX. Attach your camera where you'd like to view when flying. Wire this, as well as your transmitter, up to the proper voltage supply; in Shevett's case, this is a 5V, drawing power off of the main battery. Use zip ties to keep errant wiring in place, and shorten wires to fit the frame. Before testing, remove the propeller blades until you're ready to fly. Power the unit on, and if everything's connected correctly, you should hear the ESCs beep. The motors may also twitch.

6 CALIBRATE AND TEST

With the propellers still removed and power supplied, plug a USB cable into the FC, and into your computer. Boot up your ground-station software, then calibrate the maximum and minimum throttle positions for your ESCs. You should be able to spin up and stop your motors with the computer. Disconnect the USB cable and bind your TX to the quadcopter RX. Assign the correct channels to each quadcopter action and test the function on a bench. Once you're confident the drone is working, it's time to reinstall the rotors and take it to a clear outdoor area to fly.

7 TAKE A TEST FLIGHT

At first, you'll be flying the quadcopter without using FPV equipment. According to Shevett, if you've never flown a radio-controlled craft, "usually the next step is a brief flight and a crash". He recommends that new fliers lift their craft cleanly up a metre or two "before trying any manoeuvres" so you're at least clear of the ground as an obstacle. Once you're confident with your "line of sight" flying, you can then try out the FPV gear. "Flying FPV is *really hard*. So make sure you learn how your quad works before putting on the goggles," says Shevett.

How to...

ENDURE EXTREME COLD

Wim Hof uses breathing exercises and cold showers to train his body to withstand very low temperatures. The 55-year-old Dutchman holds the record for ice endurance – he sat in a tank filled with ice cubes for one hour and 52 minutes — and, wearing only shorts, he has run a marathon in the Arctic, at temperatures as low as -27°C. Here's how. Gian Volpicelli

How to...

Make a Mad Max ukulele

One of the craziest characters in *Mad Max: Fury Road* was the Doof Warrior, a red-clad goon who strummed a flame-throwing guitar. Maker and *Mad Max* fan Caleb Kraft decided to design his own flaming instrument. He took it down a notch, though, by making a flaming ukulele instead of an electric guitar. "I just thought it would be funnier with a ukulele," Kraft says. "But you can do it also with a guitar. I would choose a cheap guitar for this, though."

Here are Kraft's instructions to rock it the post-apocalyptic way... but don't forget to first read our disclaimer on the left. GV

What you need

- Ukulele
- Metal hose – 50cm for a ukulele
- Insulation tape
- Caulking gun
- 150ml canister of butane gas
- Spark-gap igniter from a propane grill
- ShapeLock
- Zip ties
- Hot-glue gun
- Kettle
- Drill
- Fire extinguisher

ILLUSTRATION: MARC ASPINALL; EUGENIA LOLI; SARA ANDREASSON.

DISCLAIMER: BUILDING A FLAMING UKULELE REQUIRES ADDITIONAL SAFETY MEASURES. BE SURE TO WEAR NON-FLAMMABLE CLOTHES, TO WORK IN A SAFE ENVIRONMENT (IDEALLY, IN THE OPEN) AND TO KEEP A FUNCTIONING FIRE EXTINGUISHER AVAILABLE. AS AN EXTRA PRECAUTION, WORK ON THIS WITH PROJECT WITH SOMEONE ELSE

1 BUILD YOUR TRIGGER

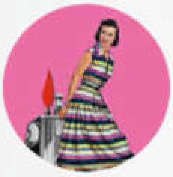
You'll have to modify the caulking gun so it works as a trigger. Unscrew the nut on the top of the plunger and pull out the plunger rod from the gun. On the gun's handle there is a tab that pushes the plunger forward any time you pull the handle: take it out and then screw the plunger rod back in position. In this way, the plunger will return in place after every pull of the handle.

2 LINK THE TRIGGER TO THE UKULELE

With the drill, produce four holes (about 2.5mm to 3mm in diameter) in the side of the caulking gun (two at each end). Drill matching holes in the back of the ukulele and attach the instrument and gun using zip ties. The gun's nozzle should angle upwards and point at the ukulele's neck. "If doing this to a guitar, use screws to fasten the gun into the guitar's wood," Kraft says.

3 FIT THE HOSE

Use the tape to secure the narrow end of the hose to the headstock. The hose's end should jut out a few centimetres from the head. Use an all-metal hose. Boil some water to soften a spoonful of ShapeLock and use it to plug the other end of the hose. Measure the canister's nozzle. When the ShapeLock plug hardens, drill a hole slightly smaller than the nozzle at the centre.



4 SET THE IGNITER

Tape the igniter's electrodes to the end of the hose on the headstock. Use the tape to be sure they don't touch the hose. Bend the two electrodes into an arc: they mustn't touch, but when you activate the igniter, they should produce a spark over the opening (the "spark gap"). If you notice more than one spark, use more tape. Paste the igniter's button on the side with hot glue.

5 FIRE!

Move to an open environment and keep your extinguisher handy. Insert the butane canister in the gun and link it to the hose through the hole you drilled in the seal. The gun's plunger should be placed against the canister's bottom. Turn on the igniter and verify it produces a spark. If the spark is there, pull the gun's handle and you'll shoot out a butane-fuelled flame.

6 PLAY

"If you're doing this for a concert, one or two butane canisters would last for a two-hour show," Kraft says. But he stresses that, although a flaming ukulele is great from a scenic point of view, you should stick to your old instrument if you care about the quality of the sound. "Having flames so close to the instrument causes the instrument to go out of tune often."

PLAY WITH FIRE

Know the cold
Hof suggests that, over ten days, you get used to progressively shifting from hot to very cold water in your shower. After ten days, stay under cold water every day for two minutes.

Breathe right
Whilst enjoying your frosty shower, you should take 30 deep breaths. You have to inhale deeply enough to protrude your belly totally outwards, and exhale in short spurts, not fully.

Do your press-ups
After your 30th breath, exhale completely then hold your breath. Then leave the shower and immediately start doing press-ups. Do as many as you can safely manage.

Face the ice
Keep up this routine for at least ten weeks. After that, you will perceive the cold in a different way: "It won't bother you any more, and you won't shiver, for instance," Hof says.

How to...

Boost your productivity using neuroscience

When we have a lot of work to do, our instinct is to do as much work as you can for as long as you can. But this is not the best option, says Josh Davis, lead professor at the NeuroLeadership Institute and author of *Two Awesome Hours*. "It's really about being highly effective for what's reasonable for a human being," he says, "a short period of time where we can really be present for what matters." **Sophia Epstein**

1

Decide what's important

Don't focus on what's urgent, figure out what's most important and find the best time to do it. It might seem simple, says Davis, "but if you were to ask me when I sit down in the morning and I've just flipped open my calendar and I've got my emails in front of me, it's very hard to differentiate between what's important and what's urgent." Rather than attempting to do this when you arrive at work in the morning, set out weekly goals at the weekend, or daily goals the night before, and remind yourself of them throughout the day. Once you know what is important you can find the right time to do it.

2

Manage your schedule

Instead of just making a to-do list and going through each item, look at your schedule for the day and pinpoint where you have time to devote to important tasks. We don't have to be at full capacity all the time, so you can perform simpler tasks that don't require much focus – emails or paperwork – outside your allocated peak productivity time. "There's stuff that doesn't need much attention and we can do that when less effective," says Davis. "We need to think more about what needs our attention and set ourselves up to really nail it during those times."

3

Don't tire yourself out

Making decisions is taxing, regardless of how big or small they are. "The more decisions we make, the less motivated we become," says Davis. "It's been found that the more time judges deliberate, the less thoughtful they actually are." Sending email may seem simple but it involves lots of small decisions. "Small decisions may be unimportant, but we're still taxing our brains as if we're making big decisions," he says. Don't sort out your email before a presentation, reorder your day so that you don't tire out your brain when you need to be effective.

4

Put your emotions to use

Understand your mindset and work with it. "Sadness helps people pay attention to details, anxiety helps people focus and positive emotions lead to better perception and collaboration," says Davis. Anger is the only negative emotion that pushes you towards something, so if you've been treated unfairly your anger could encourage you to ask for what you want. It is also possible to influence your emotions. "If you're going to be doing something that needs some creative processing, and you're just not feeling it, increase your positive emotions."

5

Clear your desk

"For the most part, people leave things on their desk that are meant to be reminders of something," says Davis, so clear them. "Our attention systems are not designed to stay focused." So by clearing away the reminders, you're creating an environment with fewer distractions. A clear desk also gives you room for more movement, whether sitting with your arms behind your head and your feet up. "These types of movements have been shown to prime feelings of power and make people more comfortable taking risks."

6

Consume the right stuff

"Food that keeps our blood-sugar levels stable is the most relevant for keeping us in a mental state that is going to help us be at our most effective," says Davis. That means if you have to be productive near the end of the day, eat half your lunch at the regular time and half later – rather than having an extra snack. If you snack during the day, keep blood-sugar spikes down by choosing fats – such as nuts and cheese – over carbs. Stay hydrated – it will improve your mood. And don't overdo the coffee.

7

Use exercise as a tool

That doesn't mean running a marathon or doing wind sprints, but 20 minutes of jogging can be used to boost your state of mind. "It's a different way of thinking about exercise," says Davis. "Usually we think about how in the long term it'll make us healthier and look better, but this is talking about the short term." A short session of moderate exercise boosts positive emotions and reduce anxiety. So if that means running up and down the stairs or jogging on the spot before a big presentation, exercise can be effective at improving your mood.

8

Let your mind wander

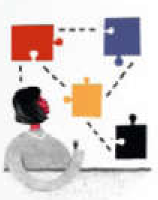
Don't be afraid of distractions – just pick some better ones. "When we decide to take a break, we go on Facebook or we check our email," says Davis, "and then we get lost on autopilot and spend more time there than we want to." Instead, we should go back to day-dreaming – where you stop thinking about your work, but don't really focus on anything else. This allows for creative thinking, future planning and the integration between different parts of your brain that cannot occur when you are focused on something specific.

ILLUSTRATION: MICHAEL DRIVER; JAMES MINCHALL

How to...

MAKE MUSIC FROM A FLOPPY DRIVE

Floppy drives, though nearly extinct now, once ruled the realm of portable storage. In addition to their capacity to store well over a megabyte of data in some cases, the drives made a unique and possibly annoying sound that any experienced geek will recognise. Application engineer and former college-band member Sam Archer decided to take this sound to the next level, and programmed a drive to actually play music. You can do the same, using his "Moppy" (short for musical floppy controller) software.



1. Assemble the parts
Archer used an Arduino Uno microprocessor to play music on a 3.5-inch floppy drive. The drive needs a 34-pin IDC connector and have the A/B select jumper set to drive B. You'll need an ATX power supply with a cable to plug into the drive. To interface the Arduino to the drive's signal pins, use a cat 5 Ethernet cable and solder the wire to the pins, or attach with a plastic IDC 34 connector.

2. Wire the signals
On the drive, there are two sets of pins. The top row counts even numbers from left to right from two to 34, and the bottom odd numbers from one to 33. Strip your cat 5 cable back and attach pins 12 and 13 to the orange and orange-striped wires, pins 17 and 18 to the blue and blue-striped wires, and 19 and 20 to the green and green-striped wires. Use the striped wires for ground pins.

3. Power on and test
Connect the ATX power cable to your drive and plug the power supply into the wall. Test the drive by first connecting the orange wires; you should see the light come on. Twist these wires together to keep the drive active. Green selects the direction, so experiment with connecting and disconnecting the green and green-striped wires, then tapping the blue and blue-striped wires together.

4. Connect your Arduino
Your processor needs to share a ground with the negative pins, so wire pins 17 and 19 into the ground connection on the Arduino. Wire pin 18 from the disk drive into pin two of the Arduino and pin 20 from the drive into Arduino pin three. Archer – after a disagreement about whether this type of music was possible – was able to get a drive to produce "Ode to Joy" in one night without instructions.

5. Get software
Download JDK with NetBeans from Oracle.com. Get the TimerOne library from https://code.google.com/p/arduino-timerone/downloads/list. Open the Arduino/libraries directory and create a subfolder named "Timerone". Place the extracted files from TimerOne.zip in this. Download moppy-advanced.zip from https://github.com/SammyIAm/Moppy and extract into folder "moppy-advanced".

6. Play music
Open the moppy.ino file with the Arduino program, and load the sketch into your Arduino microprocessor. Run MoppyDesk using Netbeans, and connect to the port that your Arduino is on. Load one of the MIDI files in the moppy-advanced zip file, and press start. You should hear music. For more info on this and troubleshooting tips, consult https://github.com/SammyIAm/Moppy/wiki.

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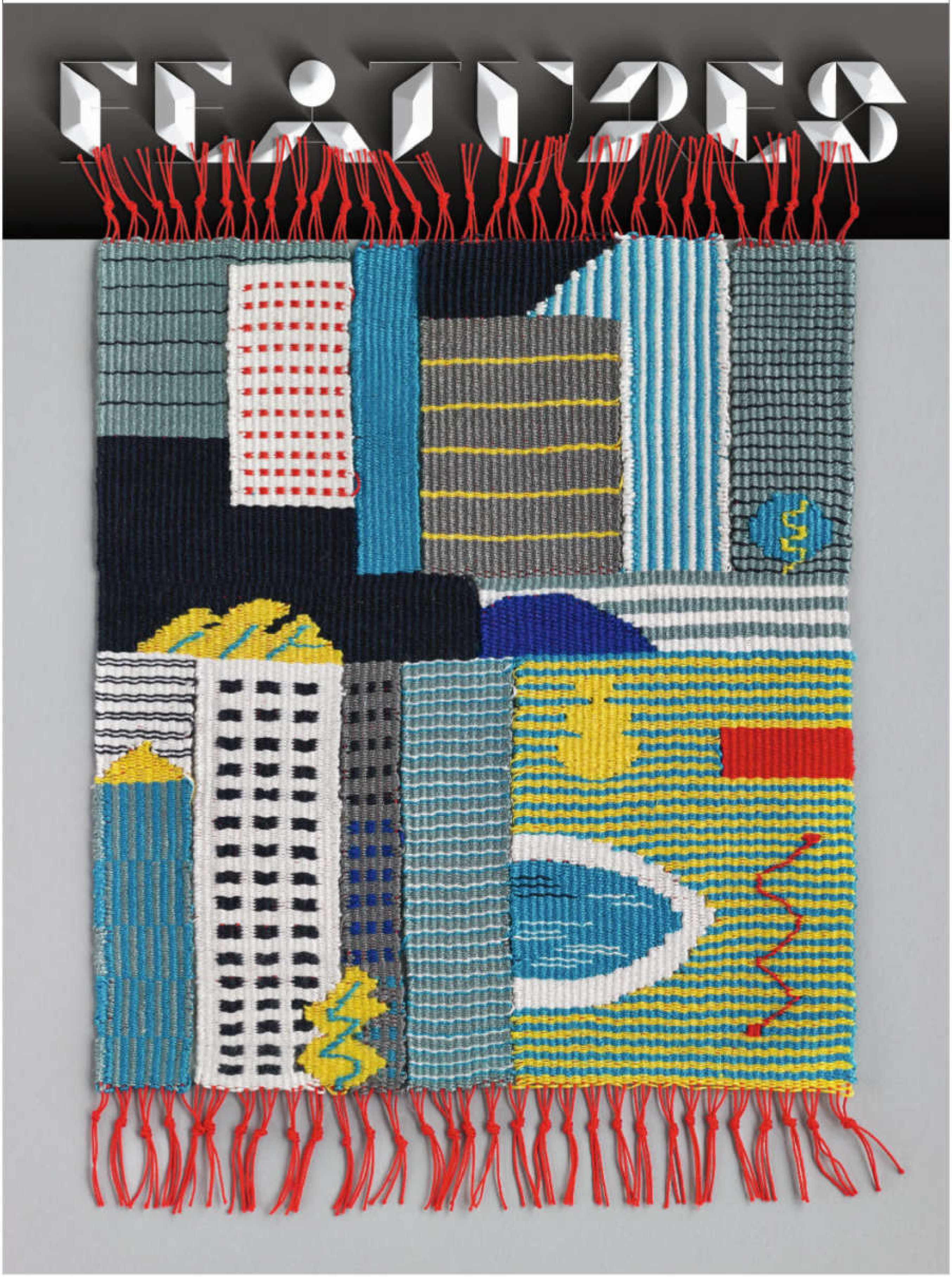


ILLUSTRATION: HANNAH WALDRON. HANDWOVEN USING TAPESTRY TECHNIQUES ON A RIGID HEDDLE LOOM IN SILK, COTTON, LINEN AND TENCEL

"*Messenger* is going to improve almost every person's life." Mark Zuckerberg, p116

IF FACEBOOK'S DAVID MARCUS CAN GET EVERY BUSINESS ON TO MESSENGER, WHO WILL NEED GOOGLE OR APPLE?

ONE APP TO RUN YOUR LIFE

BY DAVID ROWAN

PHOTOGRAPHY: SPENCER LOWELL

Beneath

a yawning seven-metre-high Frank Gehry ceiling – its outer shell covered by a 3.5-hectare Mark Zuckerberg-devised giant rooftop park; its pristine 40,000-square-metre interior decorated with posters imploring staff to "Move Fast And Break Things" and "Think Wrong" – David Marcus, a former president of PayPal, is calmly explaining to WIRED what he calls "one of the biggest opportunities in tech in the next ten years".

When Marcus made the surprise jump to Facebook to run its messaging division in August 2014, its *Messenger* app had 300 million monthly active users. A year later, when WIRED visits Facebook's cavernous new Menlo Park HQ in California, *Messenger* is up to 700 million actives, with more than a billion Android downloads – yet his team of 200 has taken what Marcus calls mere "baby steps" towards the ultimate ambition of building the company's next great global platform. "As *Messenger* has grown, we think this service has the potential to help people express themselves in new ways, to connect hundreds of millions of new people, and to become a really important communication tool for the world," Zuckerberg told 2,000 developers at his company's F8 conference in San Francisco in March, as he announced that *Messenger* was becoming so much more than just an app. "Helping people communicate more naturally with businesses is going to improve, I think, almost every person's life because it's something that everyone does."

It's the job of Marcus, a gently spoken 42-year-old French-born fintech guy, to turn a proprietary messaging app into this all-encompassing platform – essentially, an operating system on which third-party apps, and entire businesses, can be built in ways that lock them into the Facebook ecosystem. The Chinese have already shown what's possible: social media giant Tencent enables 600 million user accounts each month to book taxis, check in for flights, play games, buy cinema tickets, manage banking, reserve doctors' appointments, donate to charity and video-conference all without leaving *Weixin*, the Chinese version of its *WeChat* app.

"The messaging era is definitely now," Marcus says. "It's the one thing people do more than anything else on their phone. Some people were surprised when I joined Facebook, but it's because I believe that messaging is the next big platform. In terms of time spent, attention, retention – this is where it's happening. And it's a once in a generation opportunity to build it." Or, as Zuckerberg acknowledged in a public Q&A last November, "Messaging is one of the few things that people actually do more than social networking." And, after initially being slow to respond to the rise of mobile – which he sought to make up by buying WhatsApp and Instagram – he wasn't now going to let Facebook risk falling into second place.

Messenger began as a simple messaging app for iOS and Android in August 2011. In April 2014, it was separated from the main Facebook app; users would have to download it separately to collect mobile messages. Some questioned why the company was competing with its own acquisition, *WhatsApp*, bought two months earlier for what was then $19 billion (£12.5bn). But over the next year, as *WhatsApp* remained lean, *Messenger* functionality kept growing – video and voice calls, peer-to-peer payments, location-sharing – even as its use was made independent of a Facebook account. And then, at F8, Zuckerberg revealed his cards. "Until now, we've focused on improving *Messenger* by building all these features ourselves," he declared. "Today we're going to talk about the next step. We're introducing Messenger Platform." *Messenger* would be opened to outside developers – initially 40 pre-selected partners, including ESPN, Giphy, Boostr, Dubsmash and Talking Tom – to build new "tools for expression" that would let users create and share content inside the app. But *Messenger* would also, he revealed, let users communicate with businesses just as if they were friends – through simple conversation threads that would let them "make a reservation, buy something, change shipping information..."

In a statement provided by Facebook, Zuckerberg explains that building *Messenger* into a broader, more comprehensive communications tool is key to his wider strategy for Facebook. "Our goal is to help everyone around the world connect. It's a pretty broad goal, but we want everything we do to tie back to that," he says. "It's a big space. There are lots of different ways that people want to share and communicate. In a lot of countries, as much as 99 per cent of the people online will use SMS or send text messages – with people sending 15-20 messages or more every single day." Which makes *Messenger* "one of the fastest growing and most important members of our family".

That, Zuckerberg continues, explains the continuous iterations designed to let *Messenger* "enable you to express yourself in new ways": photo and video messaging; stickers to help you easily display emotions; geolocation to let you find your friends; *Messenger* for business; and peer-to-peer payments. Now the Messenger Platform would let people "use creative new apps to have

Stan Chudnovsky, head of product management

Mark Zuckerberg launches the platform at F8 in March 2015

Messenger 118

PHOTOGRAPHY: GETTY

richer conversations”. “We expect these improvements to continue making *Messenger* a more useful and engaging experience for people.”

It’s easy to see why Facebook is taking messaging so seriously. People send 30 billion daily messages on *WhatsApp* alone, according to the company – compared with 20 billion daily SMS messages. Even smaller apps such as *Telegram* are claiming ten billion daily deliveries. And when people are inside messaging apps, they’re not encountering web ads or discovering retailers or interacting with an existing social network. “Facebook, Amazon and Google are all threatened by the way the operating-system owner has control on mobile,” says Benedict Evans, a partner at VC firm Andreessen Horowitz who writes widely on the mobile ecosystem. “It’s why the Kindle Fire exists. It’s too late for Facebook or Amazon to create an operating system, so Facebook is thinking, how do we create our own layer on that power structure? So it’s trying to create its own runtime with *Messenger*. It’s about attention or engagement: do we become commoditised as just another messaging app, or do we do something more profound? The appeal of the *WeChat* model and some of the things Facebook announced at F8 is around service discovery: you put stuff inside a messaging app, so you have social as part of discovery. Can you turn this into a discovery acquisition channel, which is what Facebook on the desktop became?”

For Marcus, the goal is nothing less than changing human behaviour. “How people see interaction inside mobile phones hasn’t changed since flip phones,” he says. “You have a keypad to dial, a phonebook icon to access contacts, another for messages and one for your voicemail. It’s app-centric, not people centric. If today no phone existed, you wouldn’t create an app-centric view of the world, you’d create a people-centric view. With *Messenger*, everything you can do is based on the thread, the relationship. We want to push that further.”

Transforming interactions with businesses represents “the first baby steps in a series of millions of steps,” Marcus says. “Even calling a restaurant is complicated – but when it comes to calling an airline to change a booking, it ranks with a visit to the dentist – it’s really painful and nobody wants to do it. And email is completely broken. Look at the traditional e-commerce journey: you go to a website. You have to create an account – that’s one email. You add something to your shopping cart and check out – that’s another email. The package ships – that’s another email. When the package arrives, that’s another. That’s four emails that are distinct threads that are not canonical. And the only thing you can do for interactions inside an email is click on a link and go to a website, where you have to re-authenticate. It’s painful on desktop, it’s impossible on mobile. That’s why, for the majority of online retailers, north of 50 to 60 per cent of their website traffic is mobile – but only ten to 12 per cent of checkouts are mobile. And mobile traffic will continue increasing. So the thought is, what would those interactions look like if the web and desktop had never existed?”

JULIEN CODORNIOU, FACEBOOK
THU 14: 09 PM

Once you interact with a business [on *Messenger*], you open a thread that will stay forever. You never lose context of what you’re talking about

And the business never loses context about who you are and your past purchases. It removes all the friction

Sent from Messenger

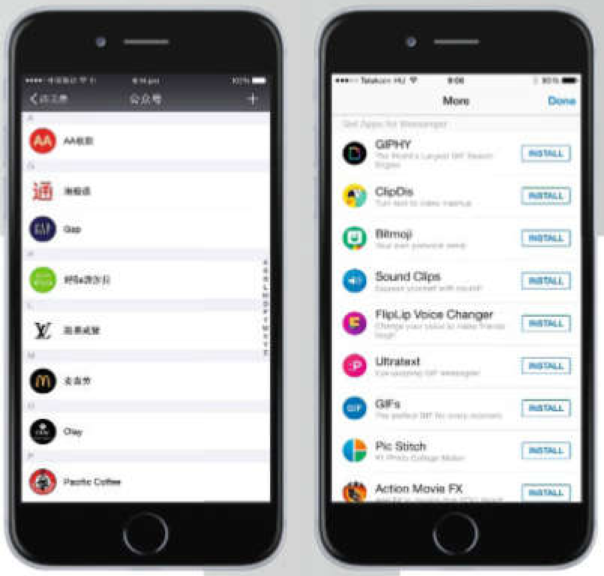
Messenger’s answer is to enable businesses and customers to communicate through conversation threads that its 14-person product team calls “interactive bubbles”. “I ordered a T-shirt yesterday from [US online clothing store] Everlane and I just got a message this morning with my shipping notification and a map,” Marcus says. “My whole history with Everlane was in that thread, and after months without any contact I just messaged them to order – and they replied, ‘Would you like the crew type like your previous T-shirts?’ You get a better experience than with a full native app.

“We’re working with a bunch of airlines, and the first one that will launch with us is KLM. When you book a ticket, you get a nicely structured message inside *Messenger* from KLM with your itinerary; you get an interactive bubble when it’s time to check in, and you get your boarding pass, your updates on gates, delays – and if you want to change your flight, you type that in the thread and they do it for you right there and then. Once you interact with a business, you open a thread that will stay forever. You never lose context of what you’re talking about, and the business never loses context about who you are and your past purchases. It removes all the friction.”

Marcus’s team is working with middleware providers such as Zendesk and FedEx to integrate businesses seamlessly into *Messenger*. “User experience is all,” explains Stan Chudnovsky, head of product management for messaging products, who also joined from PayPal. “The best user interfaces and least friction translates to happy consumers who spend more time on us.” Which also means giving those consumers access to artificial-intelligence (AI) agents to help them find what they’re looking for – even if such AIs need salary-earning human beings to augment their real-time capabilities. “There are certain conversations that can be handled by an AI quickly and easily – forms don’t work on the mobile web, free search is hard,” Chudnovsky says. “AI can solve those pain points for you. You’ll say, ‘I want the cheapest flights from New York to San Francisco, what are the options?’ And if you’re not satisfied with the results, you can get a human to help. If we do this right, it becomes your primary interface for getting your tasks done. That sucks in a pretty big part of intent.”

The AI capability, called M, is powered by Wit.ai, a startup acquired by Facebook last January. As Marcus describes it, M goes far beyond the informational role of Apple’s *Siri*. “You can say, ‘I need to send flowers to my wife this afternoon, can you take care of it?’ It knows who you are, your home address; it sends a nice bubble with a suggested bouquet, and you just accept it and it’s done. We’re playing around with this, rolling it out in tiny ways to see if it’s scalable. Our approach is very much one of trying crazy bold things. Some will work, some won’t – those that will work we’ll scale aggressively.

“We want to innovate in real-time communications – all the experiences that we have in video calls, or when you’re texting and see somebody at the same time, without leaving the app.



Left-right: *Weixin*'s official accounts screen; *Messenger*'s apps screen

Group conversations are important to us, including live discussions, or different sets of task management for groups of people – you're on a mountain, trying to figure out who is where."

With his PayPal background, will *Messenger* also offer businesses a direct payment service? "We don't want to build a payments business," Marcus replies, "but we absolutely need to build a frictionless payment experience when people are in threads. If I have a flight open with KLM, I should be able to book my next flight and have a one-tap purchase experience. Same for e-commerce. The first baby steps are peer-to-peer payments in the US, which will expand into different countries." He sends a dollar to a colleague through the app to demonstrate.

Still... wouldn't payments provide a tempting revenue model? "When you're a business that generates most of its revenues from advertising, it's just a better business," he says. "eBay takes a cut of every transaction and listing; Alibaba does all that for free, and makes money from advertising. Alibaba is bigger than eBay and Amazon combined, and is growing much faster. We take the same approach. We want the maximum number of transactions on the platform, while enabling the best possible mobile experience for commerce. The margins on payments aren't that high, and we want the broadest possible reach. And businesses will want to pay to be featured or promoted – which is a much bigger opportunity for us."

"I remember vividly at the F8 event in 2007 when the Facebook platform was announced, giving any developer the right to build apps on top of Facebook.com," says Julien Codorniou in the company's London office. "I was working at Microsoft, on the platform team of the biggest platform company, and I remember thinking, 'No way'. To be a platform, you need customer support and an army behind it – and Facebook had none of that. But he was absolutely right. Facebook built a $4 billion-a-quarter advertising business on top of the Facebook platform. And *Messenger* is the biggest extension of the Facebook platform since we launched in 2007."

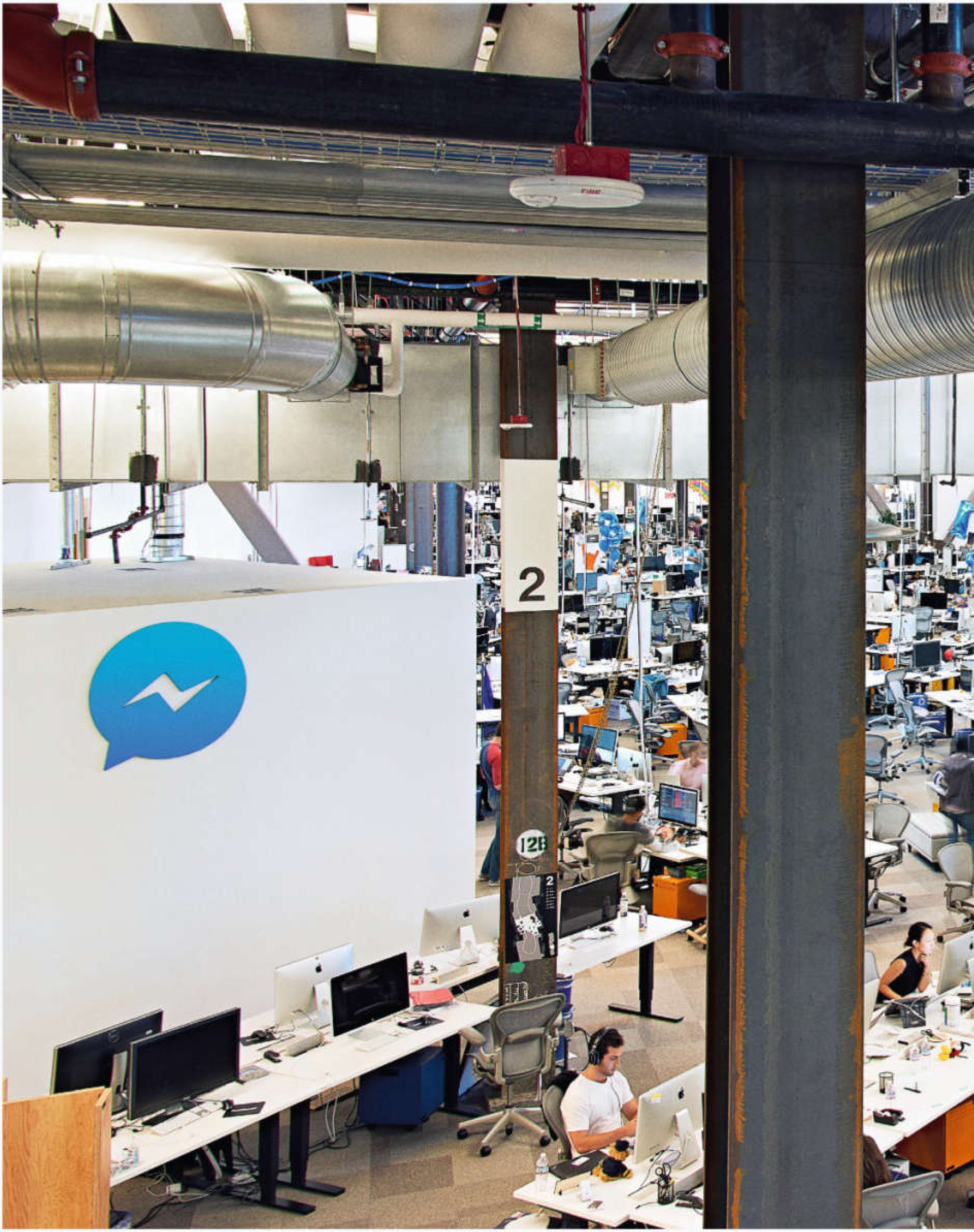
Codorniou, 37, now Facebook's director of global platform partnerships, runs teams in London, Singapore and the US who have brought in the initial Messenger partners such as Everlane, Boostr and YPlan. It's been an easy sell, he says. "Messaging apps is a business where the daily retention is 50 to 60 per cent. Everybody wants to be in that business. We introduced a free lunch in a world where there's no free lunch. Getting organic traffic on mobile is way, way harder than on the web. And the average Facebook user on mobile goes back 14 times a day – spending 46 minutes a day."

For some of the platform's launch partners, the incentive is to build a more direct customer communication channel. "We sent out more than 400,000 order confirmations through *Messenger* in the four months since April, and feedback is very positive, particularly when people want a real-time chat or there's a problem," says Dave Atchison of Zulily, a Seattle e-commerce business targeting mothers with young children, which launches 9,000 new products a day. "Email over time has moved to being asynchronous and slow, and the phone is cumbersome. Customers want to communicate in their medium."

Michael Preysman, Everlane's CEO and founder, sees value in "a more human one-on-one dialogue that you can track over time, unlike email, which goes into black holes. We talk to customers like we talk to our friends, so *Messenger* is a pretty good platform from that perspective. You could also go to people you haven't talked to in a long time and say, 'Hey, what's going on?'" But the real attraction, Preysman says in his San Francisco office, is the potential to sell through the app. So far, just 20 per cent of Everlane sales are through mobile, whereas mobile traffic is at 45 per cent. "A customer service platform is nice, but ultimately we want to see if we can drive transactions, to get people to buy on the go. We do one-hour delivery in New York, and we're huge believers in instant gratification and convenience."

For other partners, the incentive lies in the power of social sharing. "Going out is fundamentally social – on average, we sell 2.3 tickets per booking," says Viktoras Jucikas, cofounder of ticket marketplace YPlan. "In the past, for friends deciding where to go, they would take screen shots of the app, send it to friends via *WhatsApp*, use SMS... That's a difficult way to share something. We want to integrate *Messenger* and make it a part of the flow."

For a global commerce business like Rocket Internet, messaging represents an unprecedented opportunity to recruit customers at scale – and potentially to trade with them in-app. "In the past, people were spending their time on Facebook, on blogs, reading – now they're in messaging apps. A company that wants to acquire customers has to be present," says Rocket's global chief marketing officer, Arthur Gerigk.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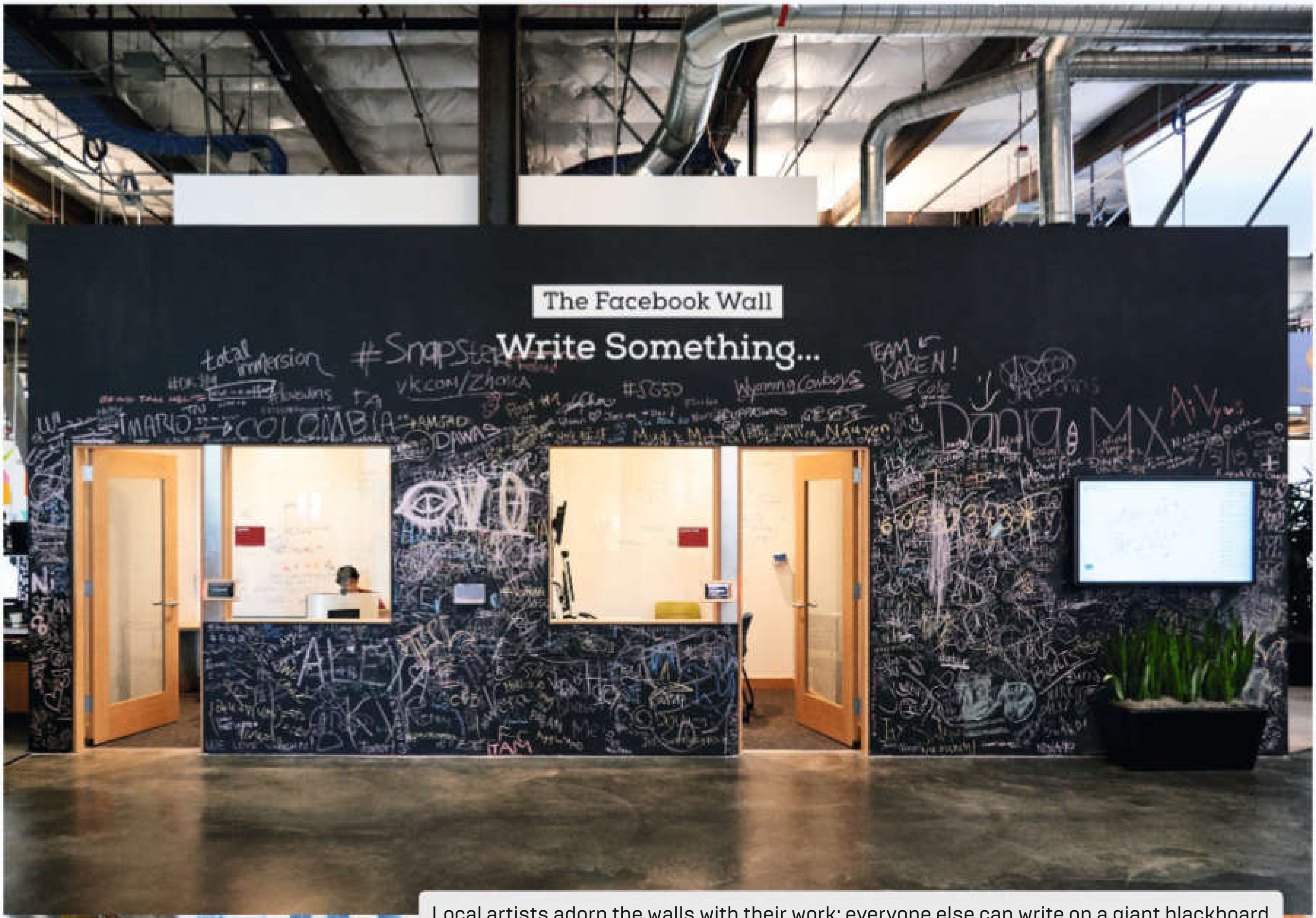
The giant open-space work area at Facebook's new HQ in Menlo Park

The garden that spans the 3.5-hectare roof includes 400 trees

Mark Zuckerberg commissioned architect Frank Gehry to design an “unassuming” build



Local artists adorn the walls with their work; everyone else can write on a giant blackboard

Floorplan maps of the headquarter's 40,000m^2 interior

“If you’re missing messaging apps, you’re missing a huge amount of reach. You have to understand that you don’t control things like you do on a website – you can’t simply show a banner or choose a keyword or spam people. You have to build up an audience.”

“We are one per cent finished, as we say at Facebook,” Codorniou says. “One day, there will be companies built on *Messenger*, and we are at the beginning of that ecosystem. We launched at F8 mainly with expression apps like *Giffy*, *Boostr* and *Legend*. But that’s the first generation. It’s going to touch companies in e-commerce, utilities, travel, dating – I’m interested in every app. Our ambition is to fuel the growth of these companies. Nobody pays for the clicks they get on *Messenger*.”

It’s the nature **of Facebook’s “Done Is Better Than** Perfect” culture that excitedly launched products can be quickly cut loose if they fail to shine (witness Facebook Gifts, Facebook Credits, Facebook Deals, Facebook Sponsored Stories, Facebook Questions, Facebook Poke, Facebook Beacon, Facebook Home...). This time, senior executives are not holding back in their declarations of intent. “We’re hoping for 90 per cent-plus penetration in the markets we’re active,” Stan Chudnovsky says. “We have very big ambitions. This is a hardcore utility – everyone has a need to talk. We’ll look back and say 2015 was when the messaging revolution happened in the western world.”

Marcus reflects on the hours we spend interacting with businesses. “If you can reduce that time and increase delight, if we can increase the fidelity of the conversations with the people you care most about, then *Messenger* will be a very important part of your life.”

Their ambitions do sound heavily influenced by the reach of *WeChat*, whose automatic authentication and breadth of functionality have allowed it to be users’ default way to play games, top up, access city services, book tickets, hail cabs and, crucially, spend money. Could this be a rare example of a western company brazenly copying Chinese tech? “What’s happening in Asia is an inspiration – and not only *WeChat*,” says Chudnovsky, “but that’s more about proof of what’s possible. It’s proof that everything starts from a conversation. There were 2,000 years when everything happened through a conversation, then a blip when the web came out when behaviour was very structured – you’d go to websites, look for things to buy, and it was straight-up merchandising when you’d assume there were no human beings behind it. In Asia, the conversation was never removed. That’s why people are discovering the world through those messaging apps.”

Besides, Facebook’s open approach to its platform differs from *WeChat*’s paid-for selective in-app partnerships. “We need to leapfrog what they’ve done, to create better experiences than you would get with dedicated apps,” Marcus says. “When *WeChat* launched, there was no Airbnb, *Uber* or other fast-growing apps. And the degree of what’s acceptable is incredibly different in the west – if your messaging app, which is very personal, is buzzing all the time with advertising, you’ll revert to SMS. The new experience you build needs to really be a big step change and make your life much easier.”

DAVID MARCUS
THU 14: 09 PM

WhatsApp is growing very nicely in developing countries. *Messenger* is focused on developed countries. We don’t really overlap that much

After retail commerce and airline travel, Marcus is planning to take *Messenger*’s platform into unspecified other verticals before “opening the floodgates”. But won’t that cannibalise Facebook’s other messaging app? “*WhatsApp* is growing very nicely in

WHY WE’RE ON MESSENGER

Jeff Boudier

Co-founder and CEO, Replay/Stupeflix

“We’ve had 100,000 downloads of our *Legend* app attributed to *Messenger*. It allowed us to put *Legend* in front of hundreds of millions of people. That level of exposure breaks through the friction of discovering new apps. App discovery is a huge issue that hasn’t been solved by the platforms. That’s why Facebook’s *Messenger* platform is so compelling.”

Romain Nouzareth

Founder, eWRLD Corp; creator, *Boostr* video app

“By opening up the platform, Facebook is going to unleash creativity among people like us – we’re going to see commerce, entertainment, news. With *Boostr*, we integrated deep-linking between two applications, and now we can reach new users with *Messenger*. Our studio’s focus is on developing apps for *Messenger*. It’s the same revolution as when Facebook opened up the social graph in 2007-8.”

Michael Preysman

CEO, Everlane

“A third of our customers are Facebook connected. If you purchase, you’re asked if you’d like to be updated about your order via *Messenger*. It’s a more human dialogue that you can track over time, unlike email, which goes into black holes. You could also go to people you haven’t talked to in a while and say, ‘Hey, what’s going on?’ Ultimately we want to see if we can drive transactions, to get people to buy on the go.”

Message boards at Facebook mix mini-golf tourneys with motivational posts

developing countries," Marcus says. "*Messenger* is very much focused on developed counties. We don't really overlap that much. Honestly, we are not thinking about competing at all. It seems the world is nicely split into countries where they dominate and we dominate." *WhatsApp*'s management, though unwilling to be quoted, also sees the two apps coexisting without significant overlap.

The trouble **with platforms is that they, rather** than the businesses built on top, set the rules. Zynga was once the world's biggest social-gaming company; then Facebook tweaked its News Feed algorithm to limit how it could promote its games. Yet Facebook's reach is hard to ignore: last year, the company says it drove 3.5 billion app installs across desktop and mobile, and more than five billion pieces of content from third-party apps were shared on Facebook's platform. This year, according to a Deloitte study that Facebook likes to quote, its platform will have an impact of $29 billion and support more than 600,000 jobs.

And yet... the platform's interests will not always align with those of the third-party businesses that rely upon it. Marcus dismisses the risk. "Every business is building on top of other platforms, whether iOS or Android," he says. "I had a conversation with airline executives who were building a new app. I asked what their target was – if, two years from now, would they be happy with ten per cent of flyers on a plane having that app? They said that would be amazing. I said, OK, what if I told you today I can give you 90 per cent of flyers with push notifications and the same app functionality with less effort? And where transactions and interactions can happen within the app because the identity is linked to it?"

It's owning the existing identification platform that gives Facebook a distinct edge. "Plugging in GIF-makers into *Messenger* – OK, that's interesting. But turning it into a universal notification platform for the web – that's much more interesting," says Evans. "Because that's when you really start hacking away at apps. That's more powerful. Do you now need to install the [third-party] app? Both Apple and Google would like to do that. But they don't have the web identification platform, unlike Facebook."

"The exciting thing about messaging," Marcus says, "and the reason I let myself be convinced by Mark not to be the CEO of a $50 billion company to build this thing, is I believe this is one of the biggest opportunities in the next ten years and this is the best place to make it happen. I don't think there's a lot of limits. We live in a world shaped by the web on mobile, but web is a desktop, not a personal experience. We see the world as people-based. If we can recreate that, it reinvents interactions on mobile from the ground up."

David Rowan is editor of WIRED. *He wrote about Oliver Samwer in 09.15*

WIRED

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PHOTOGRAPHY: CHRIS CRISMAN

PIXAR

**JOHN LASSETER,
PIXAR'S CHIEF
CREATIVE OFFICER**

**NEXT ISSUE OUT
NOVEMBER 5**

**WIRED EXPLORES THE
MAGIC-MAKING
SECRETS FROM THE
TEAM BEHIND TOY STORY,
WALL·E AND FINDING NEMO**

INSIDE & OUT

CREDIT IN

THE WIRED WORLD IN 2016

Special preview

In November, WIRED publishes its fourth annual trends report, a standalone magazine in which our network of expert writers and influencers predicts what's coming next.

Here's a small selection of what to expect

Featuring writing by **Melinda Gates, Reid Hoffman, Ben Hammersley, Alain de Botton, Werner Vogels, Yves Béhar, Stefan Sagmeister, Natalie Massenet and Russell Davies**

ILLUSTRATION: JANNE IIVONEN

Better data has the power to save more lives

Data has empowered Netflix and Amazon, and it's about to transform global development. **By Melinda Gates**

MELINDA GATES IS CO-CHAIR OF THE BILL & MELINDA GATES FOUNDATION

Here's what everybody's doing on a typical evening in our house: my son Rory is listening to the Ed Sheeran station on Pandora, my daughter Phoebe is reading a John Green book that Amazon recommended to her, and I'm perusing my personalised newsfeed on *Flipboard*. These sites run on troves of data, and we rely on them to make our lives better, faster and cheaper. So I get frustrated sometimes because my field of global development isn't taking full advantage of the power of data.

Netflix knows what movies I like. Tesco knows exactly what needs restocking on its shelves and when. But in development, we still rely primarily on educated guesses. Luckily, we're getting better.

In the year 2000, every country in the world agreed on a list of 15-year objectives, the Millennium Development Goals, with specific targets – reducing child mortality by two-thirds, for example. In order to track progress and build on it, we needed data on how many people were dying and why. So countries started working harder to collect it.

Those 15 years are now up, and many of the goals have been reached, including the child mortality target. The next step is to adopt a further set of aims, and the United Nations has just done that. But to meet the new Sustainable Development Goals we're going to need even better data, and more of it, which is where my prediction comes in.

The year 2016 will mark a sea change in how developing countries harness the true power of data to change their citizens' lives.

A couple of examples show how it will happen. First, family planning. Until recently, developing countries have tended to conduct national health surveys every five years or so. That means that in 2015, a government trying to give women the right kind of sex education and the right kind of contraceptives, in the right places, has to make assumptions based on data from 2010. But a new smartphone-based data system called Performance Monitoring and Accountability 2020 (PMA2020) has started giving governments a better version of this information every six to 12 months. In addition to collecting more data more frequently, PMA2020 also cuts in half the time it takes to analyse the data, so insights reach decision-makers faster.

Governments have begun to act on what they're learning. The Uganda Health Ministry, for example, found from its surveys that younger people weren't using family planning services. As a result, the government made reaching them a top priority in its national family planning strategy. (And PMA2020 adjusted its survey to uncover the key misconceptions that prevented young people from using contraception.) Instead of waiting five years to find out whether and how that outreach is working, Ugandan leaders will know within a year.

Another example is women farmers. Women do around 50 per cent of the farming in developing countries. Although they work just as hard, and often harder, than men, they tend to get lower yields. We've never been able to figure out exactly why – until now, because the Women's Empowerment in Agriculture Index (WEAI) is finally giving us answers. Women farmers in different countries face many common obstacles – too little financial credit, not enough control over the money they earn and exclusion from social organisations, for example – but it turns out that the proportions of those obstacles are different in different places. The biggest obstacle women farmers face in Liberia, for example, is that they have too little authority to make decisions about how they're going to farm. But in Nepal, it's that too many non-farming duties fall on their shoulders in addition to their already hard work of farming.

Based on the WEAI data, leaders in Bangladesh are running a pilot programme to find out which ways of working with Bangladeshi women farmers do the most good in certain areas of the country. This will benefit everybody, by the way; women aren't only farmers, they're also the carers of farm families. If they can grow more food and earn more money, they will invest in things like education and health that lead to a better future. The data will help start this cycle.

I know some people think data is boring. And global development still has a lot of catching up to do. Maybe my prediction for 2017 will be that development organisations will start coming up with better acronyms. But you know what isn't boring? Saving people's lives. And the richer our troves of data, the more lives we can save.

2016 is the year we're going to start getting it.

ILLUSTRATION: MAYA STEPIEN; JAMESPOP

Social networks will help education to realise its true potential

The growth of online platforms means education will be next to connect. **By Reid Hoffman**

Facebook and LinkedIn have been around for more than a decade. Twitter is almost as old. In 2015, social networks are so all-encompassing it's hard to imagine how we ever lived without them. Similarly, it's easy to imagine that the ones we currently use are enough. How many different places do you really need to present your digital self to the world – especially when that self is built around your actual name in most instances. Three? Five? Ten?

Obviously, it varies for each individual. But there are still major networks to create. So, I predict that, in 2016, we will see at least one education network go mainstream.

In education, people maintain unique identities and relationships, and optimal outcomes are key to one's overall quality of life. As such, it can benefit from the efficiencies, amplifications and accelerations that networks create.

To fully appreciate the value an education network can unleash, just think about the critical role that more general networks already play in how we identify important new ideas and innovations, and spread them faster. Ten-plus years ago, the key competitive edge to winning in business involved accessing information more efficiently than one's competitors. Those who did this were better informed, had more context and could see more clearly where things were heading.

REID HOFFMAN IS CO-FOUNDER AND EXECUTIVE CHAIRMAN OF LINKEDIN

Today, all this holds true. But how you achieve this competitive edge has shifted. We've entered what I call the Networked Age: an era where what you know is framed by who you know.

In the Networked Age, our friends and colleagues find and filter information that is most useful to us. Networks make it possible to engage in extremely high numbers of interactions and transactions, in part by aggregating and redistributing trust. You may not know the eBay seller who is promising you an item. But you do know that 479 other buyers in eBay's marketplace have rated that seller favourably, so you proceed with the transaction.

I'm keen on many networks, because people are complex, with many different facets. We engage in a variety of pursuits, in a variety of environments, and often the relationships we maintain in these environments are unique to that realm. One way to get a sense of how many identities people maintain is to simply look in their wardrobes. We have different clothing for different facets of our identity and different modes of behaviour. You can think about social networks as digital clothing. They're what we "wear" to present different versions of ourselves online, as we engage in different pursuits.

Of course, many of these networks aspire to be the shirt you can wear anywhere. But there is still a significant need and a demand for much more targeted

'I predict that we will see at least one education network go mainstream'

networks and platforms. Although you might be able to pull off a high backhand volley in a tuxedo, you're likely to perform much better in a tennis shirt.

Networks are the same: general-purpose networks are obviously valuable, but there's a growing role for more specialised ones. In 2005, we hit one billion global internet users, a benchmark that helped usher in the era of social networks. Just ten years later, we're at more than three billion global users, many of whom access the internet via phones and tablets.

In other words, more people are using the internet more often, in more places than they were ten years ago. That's creating an opportunity for a whole new generation of networks that cater to various aspects of personal identity and the relationships associated with them.

Roughly speaking, Facebook is where you maintain personal relationships. My company LinkedIn is for your professional life. Twitter is for what's happening now. Pinterest, Tumblr, YouTube and Instagram are venues for sharing your creativity.

These are generalisations and there's overlap in many of these networks, but they're all fairly broad and flexible, and in part that's why I think there's so much growth left. Magazines didn't stop at *Time* or *Life*. Television didn't stop at the BBC and ITV. In the cable era, we saw the rise of hundreds of "specialised" channels that can still reach hundreds of millions of people.

Over the next decade, we'll see a similar trajectory play out with platforms that are explicitly built around networks. NextDoor, for example, where I serve on the board, is built around a person's identity as a member of a specific geographic community. Edmodo, where I'm also a board member, is an education-oriented network that caters to people's identities as teachers, students and parents of students. I was involved in the first round of funding for Change.org, which is a network where people establish and maintain their identities as participants in civil society. Kiva.org (I'm a board member) is a micro-finance network where lenders provide zero-interest loans to entrepreneurs.

In the Networked Age, technologies shift overnight. Opportunities span the globe, but so does competition. As I wrote in my book, *The Start-up of You*, individuals must cultivate an adaptive, entrepreneurial mindset to survive. Education is the key to success – starting at the K-12 level (pre-school to year 13 in the UK) and continuing throughout one's life. In developing countries, this dynamic is even more pronounced – smartphones are often the only device for knowledge acquisition.

The more people recognise that education equates to prosperity and security in the Networked Age, the more they'll recognise the importance of using networks to enhance their educational efforts. Think about the current landscape. Schools have spent billions investing in laptops and tablets for their students. Thousands of content creators are producing courseware, ebooks, video, study apps and tools. As platforms such as Khan Academy, Udacity, Coursera, Alt.school Lynda.com (which LinkedIn acquired for $1.5 billion in April) come online, the opportunities to pursue education at all stages of life are becoming more ubiquitous and more flexible.

To utilise these abundant resources most effectively, it helps to have a network of trusted peers and allies providing context, recommendations and other kinds of information and feedback, collectively and in real-time. Ultimately, education is a highly social activity. Humans learn by modelling the behaviour and internalising the experiences of others. When people learn in social settings they retain information better. That's why educational networks make so much sense.

Also critical is the fact that education is a realm where people have very distinct identities and relationships that they'd like to maintain apart from other aspects of their lives. For example, if you're a student, your Facebook friends probably include fellow classmates – but not your teachers or your principal. If you're a parent, your Facebook friends may include a couple other parents whose children go to the same schools yours do – but only a couple.

And even then you may not consider Facebook the most appropriate domain to engage in an in-depth way about specific and confidential school-related issues. Education, in short, is a domain where a more topic-specific network can deliver much more value than a general-interest one.

An education network gives students a focused venue where they can discuss homework assignments and find tools and materials that can help them on specific subjects. It gives teachers a place to share recommendations about new courseware. It allows parents to follow what their children are learning on a more informed basis.

Education networks also make physical classrooms both more intra-connected and more extensible. Students in the same physical class can work collaboratively inside and outside the classroom, but these networks also allow students to find resources and peers outside of their own physical class who are studying the same topics.

Any classroom that is simply using its connectivity to allow students to all participate in the same massive open online course at 11am each day is only scratching the surface of what computers and networks can actually provide.

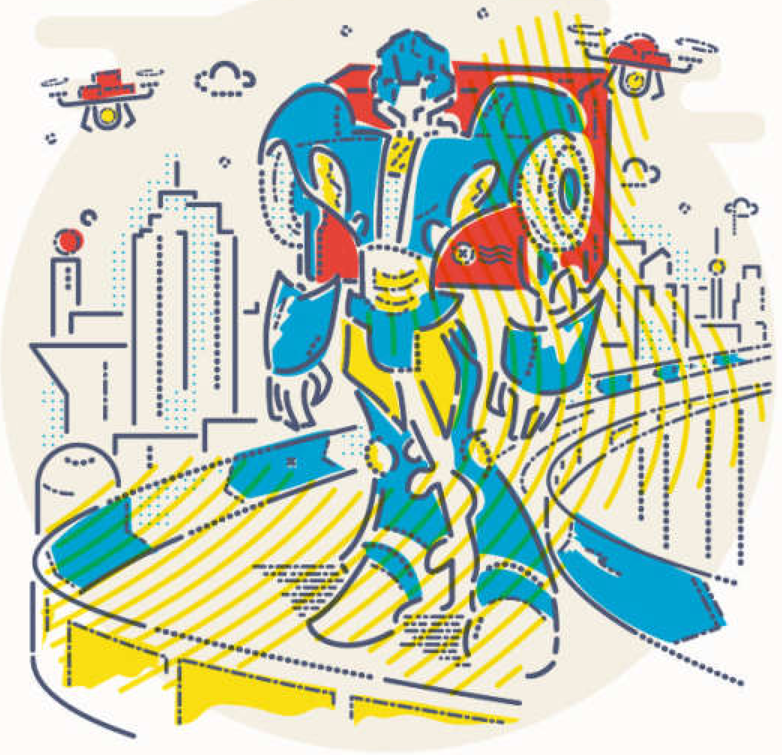
To get the most out of a highly connected, digitised world, you need platforms that emphasise personal interconnectivity. The success of platforms as varied as Facebook, LinkedIn, Twitter, eBay, Uber, Dropbox and Airbnb has shown how networks can increase, amplify and accelerate positive outcomes of all kinds. In 2016, I believe the education world will embrace this fundamental lesson – let's call it Networks 101 – and matriculate to the Networked Age.

'Education is where a more topic-specific network can deliver much more value'

ILLUSTRATION: JAMESPOP

Robot trucks will deliver us from accidents

Human error still causes too many road casualties, so give way to the self-driving vehicle. **By Ben Hammersley**



Sometimes, when you get the numbers, things are quite obviously mad. In 2013, in London alone, 187 children were killed or seriously injured in traffic accidents. Four hundred and eighty-nine cyclists died or were badly hurt. Thousands were slightly injured, or nearly missed, or just plain scared. And that's just in one city. Even though it's a huge improvement on 20 years ago, in 2013 there were still 1,713 people killed on British roads.

We all rely on cars, trucks and buses. From personal commutes and school runs to the final truck-and-van stages of the international supply chain, our society has made a trade-off: there's a certain amount of blood and mourning we'll accept if it means continuing our way of life.

But that's because there's never been a choice. Vehicles have always been controlled by fallible amateurs. Today, we're starting to see the legalisation and roll-out of self-driving vehicles. At the time of writing, the Google self-driving car, for example, has been trialled over nearly three million kilometres of public road, and although it has been involved in 14 accidents, precisely none of them were its fault. In every one, the other car – a human-driven one – drove into it.

Of course, self-driving cars aren't a guaranteed success. People like driving too much. But self-driving trucks? Those are a different matter.

In the inner city, a human-driven truck is an unintended cyclist-killing device. Once self-driving trucks arrive, however, the situation changes entirely. Even a handful of fewer deaths a year, say, and we'll have a statistically provable moral argument. Humans shouldn't be allowed to drive trucks. They will be banned from doing so and 2016 will be the year in which public opinion will begin to sway in this direction.

BEN HAMMERSLEY IS A WIRED CONTRIBUTING EDITOR

The shift from radical innovation to societally mandated usage will be swift. First the robot trucks will be a novelty, and we'll be nervous of them. Then we'll marvel at the precision of their driving, and perhaps be unnerved by their law abidance. A few months later, we'll hear of people who were almost, but not, hit by one – telling stories of pedestrian error we've never heard before, because the protagonist was usually killed. Human-driven trucks will start to appear erratic and, given laws demanding drivers stop and rest and eat and such, noticeably more expensive. And then the numbers will come out, and the AI will have been much safer.

From there, it's easy to save 1,000 lives. We'll mandate that only self-driving trucks are allowed in city centres, perhaps with dedicated lanes on the major roads. That will allow for the AIs to go faster than humans safely can, and sky lanes above for local delivery drones. Cyclists can share the streets without worry, AI-flown quadcopter fleets can operate without fear of falling on someone, and the driving of a car can slowly become a fetish activity. It's the future, it's inevitable, and it will save lives.

No experience necessary to gain the wisdom we all seek

Artificial Emotional Intelligence will put old heads on shoulders of all ages. **By Alain de Botton**

ALAIN DE BOTTON IS A PHILOSOPHER, WRITER AND TV PRESENTER

Artificial Intelligence (AI) is the science of making clever machines. It's coming along very well. There are already some phenomenally smart boxes out there, including the ATM, your mobile phone and the automatic landing system on an Airbus A380. People can do all the tasks these machines perform for us, only much more slowly and very much less reliably.

When people think of how machines will help us in the future, the emphasis naturally falls on the performance of rational executive tasks. But one should also envisage a far more exciting scenario, one in which computational power is also directed at the emotional and psychological dimensions of existence. It is time to imagine not merely AI but also, and even more significantly, what we here call AEI: Artificial Emotional Intelligence.

We need AEI rather badly because our emotional frailties dwarf our incapacities in raw mathematics or data management: we make extremely poor decisions about how we should manage relationships. We have little idea what job to focus on and when to quit. We don't know what to spend our money on. We get holidays wrong, have no clue how to repair friendships or handle tricky employees, and fumble as to how to reconcile with our parents.

The emotional intelligence required for these things is in very short supply. It exists, but in isolated and mysterious pockets: a few people seem to cope but on a basis that is desperately private and concealed, the way that a wild strawberry might have seemed before the invention of farming.

Of course, at heart, emotionally wise decisions aren't luck at all. They are the result of our brains resolving certain puzzles very well – and they are therefore logically also forms of intelligence that can be replicated and improved upon artificially, with the help of microchips and code.

'We have no clue how to handle tricky employees or reconcile with parents'

We are at a juncture in history where we can already perceive what is coming: a particular type of scarcity will start to give way to abundance. A transformation that has occurred many times before in different areas of existence – agriculture, transport and energy – is about to strike the field of emotional intelligence. We're about to make emotional intelligence as common and as cheap as pencils. We're not used to thinking that the next big thing will be tackling the scarcity of wisdom, but this is what's on the cards.

Six areas that AEI will revolutionise:

1. Self-knowledge

Knowing yourself is at the heart of directing efforts successfully – and communicating inner needs and perspectives to others. The idea of self-knowledge has always had high prestige, but the opportunities for acquiring it have been restricted. It's taken too long, been too chancy or too costly (if sought via therapy).

At present, we are often deeply ignorant about where our talents lie and what our flaws and true interests are. Our consciousness doesn't grasp at all well what is happening to its owner. For example: I might not realise that I am irritable because I'm tired, not because my partner is being obtuse. But AEI will get us the self-knowledge we need. It will map brain activity and alert us in good time as to the reality of our psychological lives.

We will get much better in two areas in particular: knowing what job we should be doing, and knowing whom we should try to form a relationship with, and how.

Today's dating questionnaires and career counselling tests will – from the perspective of 20 years hence – seem as barbaric and hopeless as medieval brain surgery strikes us now. We will at last be equipped with machines to which we can address the truly important emotional questions of life.

AEI will give us a picture of our inner selves which will stop us making catastrophic errors on the basis of a fatal inability to interpret our own emotional functioning and psychological potential.

ILLUSTRATION: MAYA STEPIEN

2. Education

Education goes desperately wrong, because we're not good at knowing what particular individuals are capable of, what they really need to know, when it's best to try to teach them – and what manner of instruction will suit them best.

We all know from our own lives that there are moments when we've made remarkable strides and others where progress has been slow, but our society has yet to arrive at sound generalisations. The idea of how you make a "good" teacher is still shockingly mysterious.

People are therefore funnelled, sheep-like, into classrooms and talked at for hours in ways that serve a lot of them rather poorly. But our educational problems aren't just around schools; throughout life – in relationships, at work, in families – we are always stumbling because of deficiencies in learning. AEI will help us to evolve towards the best versions of ourselves. We should – ideally – die with far fewer regrets.

3. News media

We're agreed that high-quality, widely-disseminated information is vital to a flourishing society. That's why certain news organisations make huge claims about how well they keep us informed.

But, in truth, news media feeds our brains in highly inadequate, sporadic and often manic ways. We do need good information, in the right doses, about the right subjects, to help us lead our lives. But we're currently far from getting it.

This matters because the media sets the backdrop to politics: it establishes the general picture of what life is like in our society (of which we witness only a tiny portion first hand) and defines the parameters of what politicians can change and address. Getting the right information into wide circulation, however, is exceedingly difficult, because our brains are designed to be more engaged by the wildly exceptional, rather than the important and the sober.

In a future with AEI, we'll know how to lead people to information that is genuinely fruitful for them and their nations, rather than merely stories that shock, titillate and horrify. We'll get better media and, in turn, more democratic politics.

4. Art

Great works of art are, at present, incredibly rare. A Tolstoy, Picasso, Lennon or Louis Kahn are still agonisingly unique. AEI will stop us having to feel so grateful to them. We will, for example, be able to produce novels like those of Tolstoy on an industrial scale, but geared towards our own particular circumstances and cultural references. *War and Peace* is often appreciated for its wisdom and insight. But the author exercised his mind on understanding the world he knew: that of wealthy Russians living in the 19th century. As his readers, we are left alone to guess the implications for our own radically different lives.

With AEI to hand, we would be able to summon up a Ugandan Tolstoy or an east London Tolstoy: the same level of maturity and compassion, the same verve in characterisation and storytelling, but all focused on what it's most important for us to dwell on.

5. Shopping

Consumer society is really about choice, and in so far as it makes us happy (rather than leads us to squander our wealth and energies), it's about wise choice.

This opens up a huge area for AEI. At the moment, we tend to operate on a mixture of intuition, hope and habit, and are routinely abused by advertisers along the way. We're heavily influenced by what others are doing: impulse plays a big role and we leave much to chance.

AEI will mean encoding consumer intelligence. Just as we might work out a sum in our heads and then check it on a calculator, so we will check our decisions on an AEI device. AEI will reveal how we can be persuaded, moved and motivated to acquire goods and services in line with our true needs. Money will, at last, make us as happy as it can.

6. Relationships

It's extremely hard to be wise around relationships. We struggle to communicate, are impatient when we don't get what we want, defensive in discussions, and have trouble talking calmly through hopes and failings around fidelity.

AEI means we will be able to tap into the lessons that others have, often painfully, learned. Each couple will not have to confront each hurdle anew late at night in the bedroom. If you could, at critical moments, (in your head) dial up your most patient, experienced and sensible friend and get them to talk you through an issue, a huge quantity of distress might be avoided. Relationship AEI will give us all access to the ideal friend's wisdom when we most need it.

There are currently some big worries over AI: what if machines take over that are really versions of very cunning, powerful people? But the cure to these is to focus on what sort of intelligence AI should emulate and enhance. Increasing emotional intelligence is key to all that we most value: empathy, creativity, kindness and generosity. Today, the major impediments to progress are all psychological. It's mainly the flaws in our emotional capacities that ruin existence. But we've not yet addressed how to make ourselves more mature. It's been left to the hazards of individual experience. AEI will use technology to reduce the randomness.

The sensor network emerges from cold storage

The internet of things once meant connected fridges, now think intelligent street lighting. **By Werner Vogels**

We have moved beyond the fridge. In the 90s, when the idea of an internet of things (IoT) was first tabled, we were promised that by the turn of the 21st century we would all have refrigerators connected to the internet in our homes. These would be able to tell us when we needed more milk, eggs or cheese and would automatically order them for us. Despite this promise, we are yet to see our fridges do the shopping. We are now more likely to see the IoT associated with the machine that manufactures our fridge, rather than the fridge itself, with a new trend called the industrial internet of things (IIoT).

WERNER VOGELS IS CHIEF TECHNOLOGY OFFICER AND VICE PRESIDENT OF AMAZON

The ubiquitous availability of bandwidth, computational capacity and near-infinite amounts of storage at our fingertips through the cloud has been key to driving the IIoT. In the past year, we have started to get a glimpse of what is possible through the pursuit of a more efficient gas turbine, real-time fleet maintenance of trucks and oil and gas. The IIoT is, for me, even more exciting than the connected fridge. It is already changing how we design and interact with machinery.

Many of the changes brought about by the IIoT have been subtle, but we can point to many examples where this trend is changing the world around us. Philips CityTouch is one example. CityTouch is an intelligent light-management system for street lighting. It allows entire suburbs and cities to actively control their streetlights in real time. This allows local councils to keep certain streets well lit to accommodate high foot traffic, turn on lighting during adverse weather when ambient light dims to a dangerous level, or even turn lighting down where there are no people around – in an industrial estate, for example. They are also able to change the colour of lights, which can help direct foot and automobile traffic, for example, allowing people to follow the green lights so they can safely get from the football stadium to the train station.

This technology has been possible because CityTouch is using the cloud as the back end that runs the system, extracting business value from data collected from sensors installed in the lights. The rise of the IIoT would not be possible without the cloud. Just consider that the UK has more than 5.6 million street lights alone – if each were to produce even a small amount of data each day, it would mean a vast amount of information to process, store and manage. The cloud is able to keep up with this rapid growth and help to create new business models. When a street lamp is not only a source of light but also a thermometer, barometer and traffic sensor, the possibilities for this network of connected devices increases.

Fossil-fuel companies are also using IIoT strategies to manage and gather data from operations in remote, often dangerous, environments to make better decisions on where to prospect for resources. Shell is using data from sensors in its wells to increase oil and gas output. Each sensor generates about a petabyte of data. Shell is estimated to own more than 10,000 oil wells. Managing and analysing this amount of data would have been unthinkable a few years ago, even to industries such as oil and gas, which are used to dealing with large datasets. Now, with the constant flow of intelligence from the sensors in its wells, combined with increased computer power courtesy of the cloud, invasive drilling becomes a last option. Researchers and engineers can spend more time on looking for the right oil fields and less time on drilling for resources that may not be there.

'The explosion in IoT apps has taken a different path to the one we expected'

Another sector where we are seeing the rise of IIoT is utilities. The best example of this is the work General Electric is doing. It is one of the world's largest manufacturers of turbines and generates 30 per cent of the world's electricity. It is also using hundreds of sensors and advanced analytics to make its fleet of gas turbines run more efficiently. General Electric estimates that improving productivity by just one per cent could drive hundreds of billions of dollars in savings.

ILLUSTRATION: JAMESPOP

In manufacturing, the IIoT is delivering real-time conditions on the factory floor, making it possible to not only optimise production and eliminate waste but uncover new business opportunities. Tata Motors, one of the largest manufacturers of commercial vehicles, is putting sensors into its trucks and has built a service model, giving owners of large fleets of trucks a better insight into how their vehicles are running, how they are being used and to predict and prevent potential breakdowns. The sensors in the trucks can be used to monitor driver behaviour, which can then be used by insurance companies to help set better premiums.

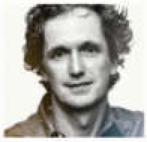
These examples are just a glimpse of the IIoT's potential. We will begin to see new kinds of sensors, with new kinds of workloads. We are beginning to see video cameras being used as a sensor for IIoT workloads. A video camera is no longer just a simple recording device, but a complex sensor that can monitor a vast number of data points at once. In a vehicle this could be a camera pointed at the wheel taking in data on the wear of the tyres, brake pads and disc rotors while at the same time monitoring the car's wheel alignment, suspension and handling. In the traditional IIoT model this would require a sensor on each of these components, but with the video camera as the sensor, all of this data could be ingested and analysed in near real time to help with the ride of the car or preventative maintenance.

Many innovations in IIoT are yet to be realised and the results of all of this will impact consumers' day-to-day lives in ways we can't imagine. Does this mean we will never have connected fridges? I don't think so, but what we have seen is that the explosion in IoT applications has taken a different path to the one we expected.

The IIoT will change how we design machinery and the systems built on them, from manufacturing plants to airports. As such, we will have a more intimate understanding of these systems to be able to achieve higher reliability and efficiency. These changes will certainly affect how we live and interact with our environment.

Connection is just a screen-free touch away

Invisible interface technology will allow us to interact with others, rather than be distracted. **By Yves Béhar**



YVES BÉHAR IS FOUNDER AND PRINCIPAL DESIGNER OF FUSEPROJECT

The smartphone is the greatest technological phenomenon of our time. You can now access the world from a screen in the palm of your hand has been made possible – including the paradoxical crossing of globalisation and placelessness. From a technological perspective, this has been inevitable since the rise of the television: the screen provides a sense of immersion that is irresistible to us.

There is an immediate side effect, however: this eternal access means we no longer have to go searching. We can now see almost anything from our smartphones. We can text or check someone's social-media feed rather than make a personal visit. We can work from anywhere, learn from anywhere and experience our lives through the little screen in the palm of our hand.

Until now, that's the direction technology has taken us – living and gorging on screens with our heads down in our phones. But 2016 will be the year this changes. Why? Because we know something is wrong. The loss of humanness is very real. We also know that technology has the profound potential to enhance our experience of the world around us, rather than distract us from it.

I call this the Invisible Interface – a movement wherein technology still provides us with information and gives us command of our surroundings, but through discreet signals rather than screens. It is not that different from the way we orient ourselves in nature: we look at the Sun to understand how much daylight is left in the day; we feel a breeze and turn towards it to scan the horizon for the sign of a storm.

This new approach to the transmission of information is much harder to build than pixels on a screen. And yet it is so much more rewarding for the designer, because the resulting user experience is natural, fluid and non-interruptive. Information and action is then woven into our lives so discreetly that, if it weren't for the magical experiences it creates, we would forget it is there.

The big challenge is that an invisible interface needs to communicate the right signal at the right moment. This means predicting the user's intent to receive the information, and enabling action or command thereafter. It takes a great deal of sensors and software to achieve this, and a good dose of human emotional intelligence too.

An invisible interface can work in any number of ways. Proximity is a good start: products reacting to our physical presence or our movements, signalling and recognising activity. This is what we had in mind in designing the August Smart Lock. What if my door knew that I was approaching, how quickly I was travelling, and unlocked itself for me, just in time?

'The smartphone provides a sense of immersion that is irresistible to us'

The technology behind the August Smart Lock is relatively accessible. But design isn't about the technology itself. Design is about ideas. And what design does best is accelerate the adoption of new ideas. The biggest design feat with August was to craft a magical interaction whereby the user receives discreet signals, such as a chime from the lock or a vibration in the phone. These tell the user that the product is taking an action, without requiring an action, in reality a distraction, from the present moment.

As sensor technology becomes more and more accessible, it will be the designer's job to curate how this information is fed into our lives. By accumulating information and making it relevant to me and the way I live, I am able to make positive decisions and know more about the world around me. That is how technology empowers us.

Motion sensors, voice sensors and gesture are getting smarter and more accessible. But experiences that we can't live without are rare. I believe this is where design is crucial as it has the potential to make technology:

▲ **Intuitive.** If it is more difficult to use than a light switch, it will likely never be fully integrated into our everyday lives.

▲ **Empowering.** Technology needs to remove complexity. To most of us, technology mostly seems to be adding complexity.

▲ **Experiential.** Technology does not have intrinsic value. It has to deliver value by enhancing the way we experience the world around us.

By removing the display, I hope we will be able to deliver intuitive, empowering and experiential daily moments. As people long for meaningful experiences, for interactions, for presence, there will be a shift toward fewer screens. This is not a shift toward less information. In fact, more information will be communicated in the subtle ways that make us so very human.

Aesthetic pleasure will triumph over function

Beauty for its own sake is coming back. Just ask Apple. **By Stefan Sagmeister**

In 2016, beauty will make a comeback in design and architecture. Pure, formal beauty is an ancestral human value: *Homo sapiens* wanted their stone axes to be perfectly symmetrical not for functional reasons, but because they would look prettier that way.

From antiquity to the 19th century, beauty for beauty's sake was considered as important as moral goodness. That sensibility changed after the first world war: beauty was sidelined as an artistic strategy. Think of Marcel Duchamp's urinal, *Fountain*, which was a statement that dismissed aesthetics in art. Or Bauhaus in Germany, which argued that, primarily, objects must function. Today, that mindset is still entrenched in design and architecture. Few designers would have the guts to present something and say, "Oh, I've done that because it's more beautiful!" Every design choice has to have an attached argument steeped in function.

This way of thinking is completely wrong: beauty is, in fact, part of the function. It's not by chance that an aesthetically aware company such as Apple has achieved such dominance. And, slowly, designers and architects are realising that beauty improves quality of life. For instance, New York's High Line park, which serves few practical purposes other than its aesthetic, has triggered a sort of virtuous cycle: the new buildings mushrooming around it are more beautiful than those you usually see in Manhattan. As beauty's real impact becomes clearer, we can expect more cases like this – 2016 could be a watershed year for decision-making based on aesthetics. A major example is Herzog & de Meuron's Philharmonic Hall in Hamburg. Although plagued by delays, it nevertheless exemplifies a gorgeous form: not only can the building be read as an emotional visualisation of the music it will house, it makes the viewer want to go inside and listen to it.

James Turrell's Skyspace at Rice University in Texas is another harbinger of the return of beauty. Viewed at dusk or dawn, it frames a section of the sky in such a mesmerising way, that I've never looked at sky in the same way. The National September 11 Memorial in New York City, designed by Michael Arad, is surprisingly beautiful – and the beauty is functional. The masses of falling water eliminates all other noises and allows for real contemplation.

In a world in which we are overloaded with sensory information, beauty will be one of the most important ways that designers can differentiate their products and create wonder amid increasing complexity.

'It's not by chance that such an aesthetically aware company as Apple has achieved dominance'

STEFAN SAGMEISTER IS CO-FOUNDER OF SAGMEISTER & WALSH

ILLUSTRATION: JAMESPOP

Collaboration is the season's new look

The future of online retail will see businesses working together – even with competitors. **By Natalie Massenet**

For many decades, business was all about competition – enterprises operated under the principle that they needed to find and exploit a competitive edge to survive and there could be only one winner. In 2016, however, I believe there will be a shift: the most successful businesses will be characterised by collaboration between businesses in the same sector, different sectors or with their customers.

Innovation in technology has fundamentally changed the way businesses function and work with each other. It's no surprise, then, that the nature of competition has changed, driven by companies expanding their offerings along with diversifying and innovating in new sectors. Technology giants such as Google and Amazon are constantly moving into new areas. Who could have predicted that a search engine would be pioneering driverless car technology 17 years later? Or that an e-commerce bookshop would now be selling everything and testing drones for deliveries?

This blurring of boundaries means that businesses, especially online ones, no longer occupy one discrete sector. Competition comes not only from the other players in your space, but also from those in other sectors who see an opportunity. This change can be viewed as a threat, or people can collaborate and help create a bigger pie for everyone to have a share of.

This doesn't mean that competition is dead. Businesses should be their own greatest competition and be willing to disrupt themselves before someone else does. The idea behind this is to move the store to where people are heading. When Net-a-Porter launched in 2000, its mission was to bring fashion to women at their desks or home through online shopping. Today, in the age of social media, it is about joining the style conversation and the communities that gather and share online.

NATALIE MASSENET FOUNDED NET-A-PORTER IN 2000, AND IS CURRENTLY CHAIRMAN OF THE BRITISH FASHION COUNCIL

Social shopping is rapidly gaining momentum. Platforms from Instagram to Pinterest influence how consumers discover items and spend their money. Consumers can shop with friends, and have a personal dialogue with the brands they love. This evolution is making it possible to collaborate in a much more meaningful way.

Businesses working together is only one aspect of this increasingly collaborative economy – the consumer is best served if we collaborate with another supplier and directly with her or him. Fashion has moved from a one-way conversation where designers and magazines told the consumer what to buy to one that invites the consumer to shape the conversation and empowers them to make their own buying decisions.

For example, if a reader sees a Chanel top in a magazine and it's not yet available to buy online, the magazine should communicate directly with Chanel and find it at no extra cost. That might sound like sending profit elsewhere, but in fact it's a win for everyone involved. The customer is happy because she has her top and will no doubt return to the magazine. And Chanel is happy because the magazine has connected the retailer with a customer. In today's world, we need to collaborate to be able to compete.

In 2016, this will grow ever more nuanced: it's important that e-commerce firms do whatever they possibly can to reduce the friction between customers and their desired product.

We are finally at the point where retailers can analyse and act upon the huge amount of data that customer interactions create. In its simplest form, this is what everyone has been calling personalisation, but it could be so much more. Amazon, for example, made huge waves with its Anticipatory Shipping patent that predicts which products consumers will buy and ships them to a nearby hub, anticipating the purchase. Innovations like these tap directly into what people want: immediate, exceptional and personalised customer service that goes beyond marketing.

The early days of e-commerce were blighted by confusing, cluttered and unfriendly user experiences. Crucially, digital businesses lacked the intuition and basis common sense that a well-staffed bricks-and-mortar shop offered. That human touch, so often missing when we shop online, will become more present in 2016 as new technology dissolves outmoded business models. This new age of immediacy demands a rethink of this approach, especially as technology now caters for whatever we want at the tap of a screen. Competition creates win-lose scenarios, but collaboration benefits us all.

News just in: the world won’t be particularly different in 2016

For a true picture of how we are progressing, we need to consider nature’s pace layers. **By Russell Davies**

We have evolved to pay attention to things that move fast. We’re good at noticing an attacking tiger, bad at noticing climate change. That’s why we have “news” and don’t have “unchanged”. And that’s why WIRED is packed with things moving fast. That’s what makes it brilliant: all the change, acceleration and disruption.

But we’d be remiss if we didn’t also point out that a key defining characteristic of 2016 will be that, for the most part, it’ll be exactly the same as 2015. And very like 2014. And much the same as 2006. And, actually, not that different to 1996, 1986 and 1976. Get a bit further back and it’ll get different, but it’s important to consider this point: most things, certainly most big things, don’t change very fast. It’s just that we don’t pay attention to them.

RUSSELL DAVIES IS DIRECTOR OF STRATEGY AT THE GOVERNMENT DIGITAL SERVICE

For instance, the world in 2016 will still depend on fossil fuels. Transport in our major cities won’t move any faster than it did 100 years ago. The best way to save lives will still be to vaccinate people and get more of them clean water. The fashion business will still exist; so will movies, music and advertising. No one working in any of those industries will have any idea how to guarantee a hit. Sub-Saharan Africa will still lead the world in mobile finance, the US and the UK will still have lousy broadband and there will still be no reliable way to determine which way to insert a USB stick.

Why spoil this prediction-fest with curmudgeonly talk of nothing changing? Because in order to understand a prediction you have to understand its context. The architect Eero Saarinen put it best: “Always design a thing by considering it in its next larger context – a chair in a room, a room in a house, a house in an environment, an environment in a city plan.” The same applies to change and to time. Just as so many apps only seem to make sense if you live in San Francisco – and they fail because most of us don’t – similarly, so many prognostications are only useful if you recognise that they’re just tiny blips in a larger picture.

In his 1999 book *The Clock of the Long Now*, Stewart Brand described his notion of pace layers – a useful way to think about change. Imagine a set of concentric circles, faster moving things on the outside, slower things at the centre. The surface layer represents fashion and trends, changing all the time. Then, as you move inwards, you get commerce, then slower again, infrastructure and governance, then more glacially, culture and right in the centre, the slow unmoving constant – nature. To truly grok the predictions outlined in these pages you need to consider them in this full-stack of context, because that’s the ground in which you’ll plant your idea.

Think about Google’s self-driving cars, currently self-driving themselves around. They seem to have cracked the technology; those things are probably safer than a human driver, but now they have to deal with long, slow layers of governance and culture. How, for example, does society deal with the fact that real drivers break minor traffic laws all the time – and that it’s often necessary to keep traffic moving? Do we want robots doing that? How do we even decide? We don’t have good ways for legislation to keep up with technology. That, I can confidently predict, won’t change in 2016.

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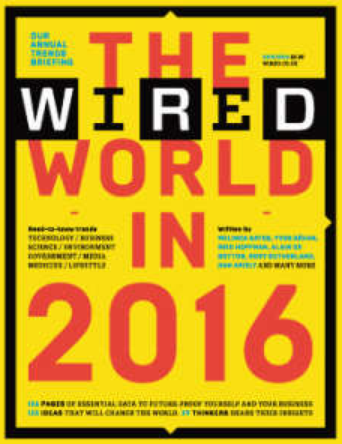

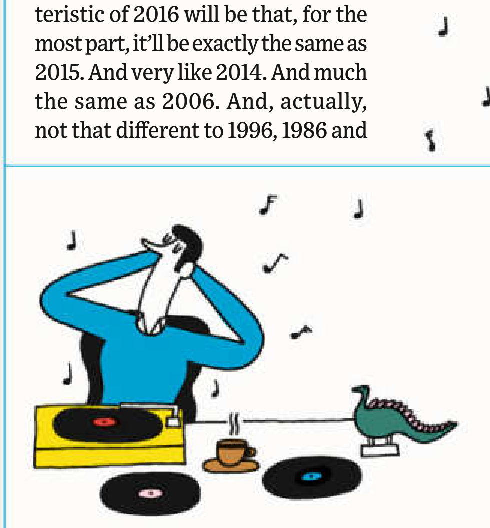

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HOW THE BOSS OF RIO DE JANEIRO'S MOST NOTORIOUS COCAINE CARTEL WAS BROUGHT DOWN BY SOCIAL MEDIA

BY
MISHA GLENNY

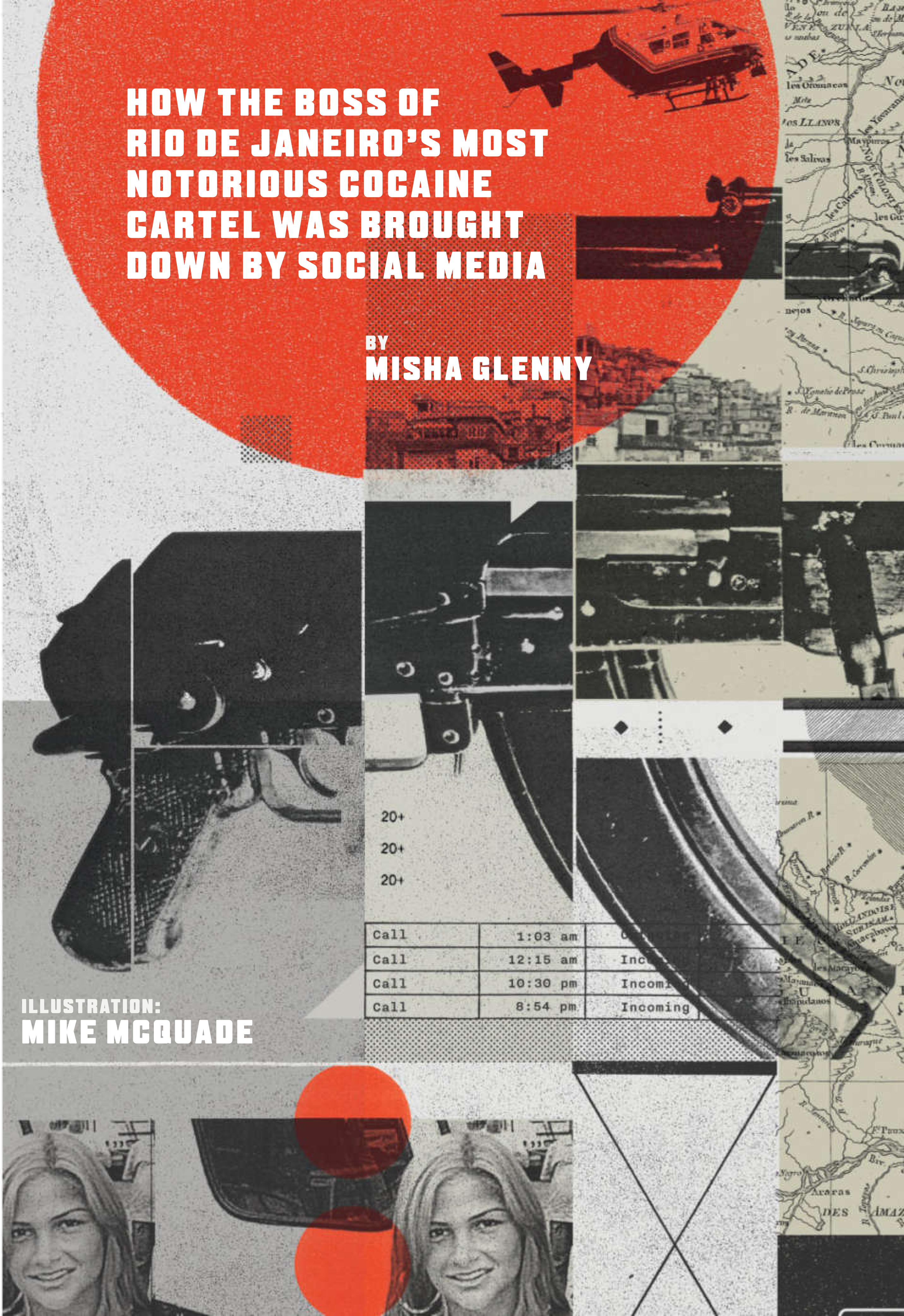


ILLUSTRATION:
MIKE MCQUADE

FROM SHARE TO SNARE

BIBI PERIGOSA WAS FURIOUS.

SHE HAD DISCOVERED TEXT MESSAGES ON HER HUSBAND'S PHONE THAT MADE IT PRETTY CLEAR HE WAS SEEING ANOTHER WOMAN.

Fabiana Escobar, known as Bibi Perigosa, poses in 2006 with a semi-automatic

Perigosa, which means “dangerous” in Portuguese, was not the most beautiful woman in the favela, but she was one of the most recognisable and popular. She had a personality that was simultaneously overwhelming and attractive.

But Perigosa was in a difficult position. Her husband, Saulo de Sá Silva, was second in command of the drugs cartel that ran Rocinha, the favela where she lived. Since Silva had escaped prison 18 months earlier, in December 2005, he'd become busier than ever – the drugs business was booming – and his success had led to a rise in income and attractiveness to other women.

There are around a thousand favelas in Rio de Janeiro, but Rocinha is the largest. It is surrounded by Rio's three wealthiest districts – Gávea, Leblon and São Conrado – where a vast market for cocaine has grown since the 80s. The rich white kids of Rio's middle class have a lot of money and like to party; and, because of its location, Rocinha is estimated by the police to shift 60 per cent of the snowstorm that falls on the city after drifting across Latin America from Colombia and Peru. Sinha had built a large part of the Rocinha cartel's market share.

Silva is short, with a square, unassuming face that reveals the multicultural heritage common among Brazilians – indigenous South American, European and African. His role within Friends of Friends (known universally by its Portuguese acronym, ADA), one of Rio's three warring cartels, was significant and, to some degree, serendipitous. Silva was convicted for drug dealing in 2004 (when he was close to completing a degree in mathematics) and consigned to Rio's notorious municipal jail, Bangu. He was fortunate enough to enjoy the financial support of Luciano Barbosa da Silva, known as Lulu, the then don of Rocinha, and bought himself a number of privileges, including conjugal visits from Perigosa. He didn't have to live in an overcrowded cell with multiple occupants but instead shared with a middle-class prisoner who had studied chemistry.

During his time behind bars, something happened that would enable ADA – via Silva – to develop a significant advantage over its rivals: Silva's cellmate taught him to turn “pasta base” (base paste), the intermediate cake, into powdered cocaine via purification. Silva escaped from Bangu in December 2005 by removing the air-conditioning unit in his cell, and quickly developed the only cocaine refinery operating out of a Rio favela – the rest of the cocaine sold in the city had already been refined in Colombia, Peru or Bolivia. As a result, Rocinha's profits tripled more or less overnight.

Perigosa's lifestyle transformed immediately. She had money to burn and she had status – but now she also had female rivals who were vying for Silva's affection. When she confronted her husband about the text messages, he denied the accusation vehemently. But, every day, he left home at seven in the morning and didn't return until midnight, sometimes later. Perigosa was left at home with their two young children going stir-crazy.

To alleviate her frustration and anger, Bibi often turned to Orkut, the social network owned by Google. At that time, the network seemed close to becoming a serious challenger to MySpace and Facebook – it was enormously popular in emerging markets such as India and Brazil. The platform played a key role in the huge rise in internet use in Brazil. Perigosa was a committed user and posted often.

“It's so boring having cash,” she posted one day, underneath a photograph of herself with her fists stuffed full of bank notes. Some of the comments she received weren't welcome: “While you're hanging out at home, Bibi,” one young woman mocked, “your precious Saulo is off screwing other women.” Then, in August 2007, Perigosa showed off by posting a photograph of herself with a semi-automatic gun Silva had left in the house. The behaviour was risky – he had already warned her to be

Saulo de Sá Silva, Bibi's husband, who was second in command in Rocinha's cocaine trade

PHOTOGRAPHY: SPIEGEL ONLINE

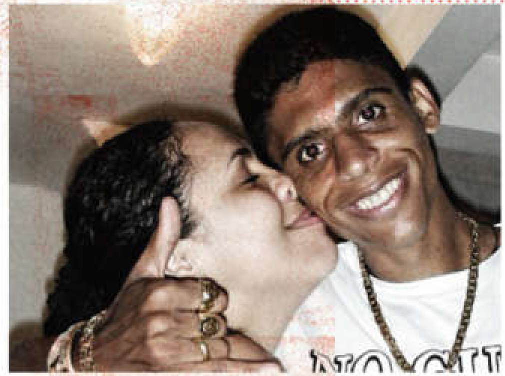
careful about what she posted. He considered social media a dangerous and unnecessary form of self-exposure. After she'd uploaded the photograph, Perigosa thought about his warning – and pulled the picture.

Later, Perigosa posted a message on Orkut asking her mother to call her. She included her own telephone number. She removed it minutes later after realising it was a foolish thing to do, but it was too late.

Every post, every photograph, every message was being monitored in real time by Brazilian investigators.

The police had set up wiretaps to monitor Perigosa's telephone calls. First they heard her in conversation with her mother. Before long, she phoned Silva. This was what investigators had been long been hoping for – now they finally had the phone number of the deputy commander of ADA.

Antônio Lopes, known as Nem, at a party with a woman thought to be Bibi Perigosa



Putting a wiretap on Silva's number was the opening move in a law-enforcement operation named Service Provider. Alexandre Estelita and Reinaldo Leal, two experienced investigators from Rio's Civil Police, were tasked with uncovering the structure, operational methods and turnover of ADA in Rocinha. The favela had a population of 100,000 squeezed into a mere 3km^2 that covers a steep hill rising from the Atlantic shore and cradled in a sloping bowl of the coastal rainforest – officers were able to enter the favela only in large numbers and needed to be heavily armed. Most of the time the slums were no-go areas where the state had no purchase or influence. After Silva escaped from prison, the detectives assumed he had probably gone to Rocinha, but they couldn't be sure. Apart from the main road, Estrada da Gávea (which, in the 30s, formed part of Rio's Grand Prix racetrack), Rocinha is made up almost exclusively of tiny little alleys and lanes made dark by jerry-rigged buildings which cannot expand outwards and so are extended vertically. In Rio's urban warfare all the advantages lie with the heavily armed defenders of the favelas. Estelita and Leal figured that they could use social media and tap mobile phones to construct the make-up of Rocinha's drug gang without physically entering the slum.

With Silva's number in their database, the two cops were able to start tracking his movements. Unsurprisingly, he never left the favela. Inside the perimeter, he was safe – no police would violate the sanctuary of Rocinha.

Estelita and Leal were shuttling between their office and the court in order to get a judge to sign off multiple phone taps in Rocinha. Silva's number soon led them to Juca Terror, another senior player responsible for communicating with other local favelas loyal to ADA. Then came several senior members of the supposed 400-strong ADA, gangsters with names such as Beiço, Cabeludo, Total, D2, Lico, Vinni. Before long, the two detectives were mapping the relationships between dozens of the men and women running Rocinha.

But they were missing a crucial piece of information: they couldn't find a number for Nem, the don of Rocinha. Within the favela he was said to be omnipotent, yet Estelita and Leal knew virtually nothing about him. He was the boss, but he had never been picked up and never been photographed. The police weren't even sure if Nem was his real name.

Antônio Francisco Bonfim Lopes, Nem of Rocinha, had been born in the favela in May 1976 to an immigrant from Brazil's north east and a semi-literate mother who traced her antecedents back to the indigenous community. The family lived in a tiny shelter made of wood and corrugated tin – Nem shared the bedroom with his parents and half-brother, who was 14 years older.

Although both his parents worked, his mother as a maid to a middle-class family and his father as a waiter, the boys grew up on a diet of rice and beans, supplemented by fruit from the surrounding forest. Nem's parents drank heavily and fought. When Nem was 12, his father, whom he worshipped, was shot in the knee during a hold-up at the restaurant where he worked. With his mother out working, Nem stayed at home to nurse him. The wound never healed and the young boy watched as his father's health deteriorated steadily. Ten months later he died of a heart attack.

Nem was intelligent but had to leave school to work. He found a job distributing Rio's equivalent of the *Radio Times* around the South Zone, the district that includes all the major tourist spots in the city, including the statue of Christ the Redeemer, Sugar Loaf Mountain and the beaches of Copacabana, Ipanema and Leblon.

By his late teens he was thin and tall, about 190cm, with a distinctive narrow face and a slight overbite. His eyes were so jet-black that the irises and pupils seemed to merge.

He soon established himself as a leader; although he couldn't drive, he was made responsible for eight co-workers and a fleet of bikes and vans. During this time he married Vanessa, his childhood sweetheart, before saving enough to move into a tiny hovel of his own in Rocinha.

In late 1999, their ten-month-old daughter Eduarda woke up crying with a stiff neck. After months of tests, doctors diagnosed an aggressive and potentially fatal autoimmune disease called Langerhans cell histiocytosis, in which the body's defences attack its bones and sometimes other organs. The treatment involved significant costs. Nem fell behind on the rent and the family was forced to return to move back to his mother's house. The medical authorities ruled the bathroom unfit for the baby and the family received a large bill for a specialist catheter required to administer the powerful chemotherapy Eduarda needed.

Rocinha is the largest fevela in Rio de Janeiro and in all of Brazil – perhaps the whole of South America

Danúbia Rangel, the second wife of Nem (in the background in a white T-shirt), poses before sightseeing Rio by helicopter

Eight months later, Nem was £3,000 in debt – a fortune for a favela resident. He had no credit, so, after much soul-searching, he decided to request a loan from the only man in the favela with enough cash to spare, Rocinha's drug lord, Lulu.

Lulu's was a cash-rich industry. He handed out loans, usually to residents who wanted to purchase their own apartment. This served a dual purpose: the practice boosted the local economy, which was largely ignored by the state and financial institutions. It also recycled the profits from the drugs trade.

Nem had never engaged with drugs, never taken them. He was revolted by the associated violence, which had been a backdrop to his life. None of his childhood friends were in the business. They were all, like him, workers – drivers, builders, waiters. But his baby girl was sick and he was desperate.

Two days before his 24th birthday he started the long walk uphill on Estrada da Gávea towards Road One, the favela's toughest area where the boss of the drugs trade had his office.

The encounter was more significant for Nem than securing a loan – soon after the meeting he went to work for Lulu. Within five years he would become Rochina's most powerful man.

Nem's rise up the ADA hierarchy was swift. Lulu valued his employee's accounting abilities and experience as a distribution manager, which professionalised the cocaine sales to the South Zone's party people. While his rivals for power within the cartel swaggered around the favela showing off their machine guns, Nem's calm disposition and business acumen fast-tracked him to the top of the organisation. He figured out that, in order to appeal to Lulu, money would talk louder than guns.

But, in April 2004, Lulu was killed by Rio's paramilitary Battalion of Special Police Operations. His death triggered a low-level civil war in Rocinha that involved 18 months of coups and counter-coups. Finally, in November 2005, Nem emerged victorious after Lulu's likely successor was murdered.

The introduction of the cocaine refinery, set up by Silva, was a boost to the business and gave Rocinha a competitive advantage over its rivals. The partnership between Nem and Silva worked well: the former used his quiet charisma and financial acumen to generate unprecedented support among ordinary favela residents, the latter upped turnover. And times were good – a few months after becoming don and now divorced from Vanessa, Nem married Danúbia Rangel, a bottle blonde with sharp cheekbones and a taste for the high life.

By listening to Silva's calls to his foot soldiers over the next year, detectives Estelita and Leal discovered that one kilo of coca paste, which cost $3,500 (£2,250), rendered the same weight in pure cocaine, which sold for $8,000. They were also able to ascertain that a single smoke shop in Parque da Cidade, a small satellite favela of Rocinha, turned over $1,250 per day, amounting to nearly half a million dollars a year. Silva later confirmed to police that the Rocinha cartel was selling to other favelas, including some areas under the control of its greatest rival cartel, Red Command.

Nem understood the benefits but also risks to his business of the emerging networked, social age. He realised that the information revolution offered many more advantages to the law than it did to dealers. He dictated that computers were not to be used for business and ostentatious use of social media was outlawed. However, he found it impossible to control some of his soldiers and their partners. Above all, Nem regarded the mobile phone as a menace. Members of his cartel were forbidden to mention his name on the phone. When they did, they would refer to him by phrases such as "the one next to God". He needed to be in touch with a vast range of contacts: almost the entire police force surrounding the favela was being paid off by ADA. According to one of the gangsters responsible for making payments, the Gringo, at any one time there were eight police vehicles on the gang's payroll– two at the top of the favela and six at the bottom. Each had two officers, both receiving about £15 per shift, a total of £720 for every 24-hour period or £260,000 annually. And it wasn't just the beat cops on Nem's payroll – there were more senior officers who received larger sums. Their primary job was to warn ADA of potential raids.

This expenditure didn't include Nem's huge expenses inside Rocinha: ADA paid for funerals, the distribution of food to the poorest inhabitants and other welfare provisions. He would need his senior managers to be contactable at any time. Wherever he went, Nem was accompanied by a member of ADA who carried a bag with 20 mobile phones. Each SIM only ever made contact with one other phone belonging to Nem's network of cops, lawyers, suppliers and gang members. The owners were forbidden to use the phones unless they had to speak to Nem. Little did he know that his network had already been compromised by Perigosa and Silva.

Nem frequently talked to members of the ADA about the importance of controlling the circulation of critical information inside the favela – and managing what seeped into the outside world. This gave the people of Rocinha the impression that he was all-seeing and all-knowing. They called him the Master, a title he encouraged. "He wasn't called the Master for nothing," Estelita explains. In jeans and T-shirts, with three-day stubble and shades, Estelita and his colleague Leal look, each time WIRED meets them, as if they have walked off the set of *Miami Vice*, yet are thoughtful and shrewd. "Nem would see himself as possessing greater wisdom than the others," Estelita says. "And he did. Apart from the power vested in him by weapons and fear, he had the power of intellect, which was allied to the power

PHOTOGRAPHY: PA. PREVIOUS SPREAD: CORBIS

he accrued through his control of information." A "master", the detective says, is a character who has information and knows what he is doing. "If there were a police operation pending, he would order his assistants to tell kids not to go to school as there was going to be a raid." This of course meant that he had been tipped off. "So others thought he was like God," Estelita says. "So far as they were concerned, he just seemed to know everything. And he sort of did."

'NEM WOULD SEE HIMSELF AS POSSESSING GREATER WISDOM THAN THE OTHERS. AND HE SORT OF DID'

Nem became popular among the Rocinha residents. This was in part because he developed an embryonic welfare state there. But his appeal was also because he had a strategy of reducing violence and homicides in the favelas.

As Rochina's economy improved, the favela developed a reputation for being safe. The slum became a brand. Everyone wanted to visit Rocinha – football stars, the top music artists, politicians, academics, tourists and even the president, Luiz Inácio Lula da Silva. The entire line-up of Rio's most popular football team, Flamengo, of which Nem is a fanatical supporter, pitched up and local megastar singers Ivete Sangalo and Claudia Leite performed there, as did the New York rapper Ja Rule. It may have dominated the cocaine trade, but Rocinha was also the only major favela with a tourist industry.

When Nem took power, annual homicide rates in Rocinha stood at about 60 per 100,000. According to a research unit into violence in the favelas at the Federal University of Rio, under Nem that number dropped dramatically to around 20 per 100,000 per year.

Nem exercised a monopoly on violence in the favela – he was effectively prime minister and chief of police. With 150 men under arms, he kept peace in a community of 100,000. Rates of theft and assault also came down.

However, as Brazil looked forward to hosting the 2014 Fifa World Cup, the authorities launched a programme to eliminate the cartels from some of the favelas. The strategy, known as pacification, involved special forces who would enter a favela in force in order to decapitate and dismantle drugs organisations. In theory, this was to be followed up with a renewed effort to build schools and health centres and to accelerate rubbish collection and other municipal services, although there is little evidence of this having happened. In 2011, the state decided that it should make its presence felt inside the favelas for the first time in 50 years. Politics, a global sporting event and the demands of big business meant that the clock was ticking for Nem.

Time was already up for Saulo de Sá Silva: one Sunday in January 2008, he had been arrested – in his swimming trunks – in a flat in the resort of Maragogi, 2,000km north of Rio, by undercover police posing as tourists. The police had located Silva via a now familiar route – Perigosa had posted on Orkut that the couple were undertaking a tour of Brazil's beaches. About 18 months later, a Civil Police team raided Rocinha and used the opportunity to make a sweep of Nem's house. They found a photo album belonging to Danúbia, his second wife. They included pictures of her climbing into a helicopter for a bird's-eye tour of Rio's tourist highlights.

A couple of days later these photos appeared in one of Rio's daily newspapers, *O Dia*. At a glance the photo didn't reveal anything that could be useful to investigators. But closer examination revealed a tall figure with a narrow face in the background: Nem. Unlike most drug traffickers, throughout most of his tenure as Don, there had been no photographs circulating of Nem. Outside the favela, nobody knew what he looked like.

Nem ordered every copy in the South Zone to be burned, but their destruction came too late – the photo was already online. Nem was no longer a shadowy figure to the authorities – they understood how his organisation worked and now they knew who they were after.

On November 10, 2011, three police forces attacked Rocinha, racing each other for the chance to arrest Nem. As the favela swarmed with elite forces, Nem tried to flee in the boot of a car.

Police arrest Nem on November 10, 2001, after finding him in the boot of a car with fake diplomatic plates

The vehicle was stopped at a roadblock. One of the passengers claimed to be a diplomat before offering a bribe of $570,000. The vehicle was surrounded by the civilian, military and federal police forces. Today, Nem is imprisoned in a high-security federal jail thousands of kilometres from Rio. He wears the penitentiary's regulation blue T-shirt and cotton trousers and his hair is now cut short – the curls are gone.

Convicted in 2013 of association with trafficking and sentenced to 12 years, he's now awaiting trial for homicide. The incarceration doesn't bother him. "If it happened all over again, I wouldn't do anything differently," he says. The reason is simple: Eduarda, his daughter, is now a 16-year-old who is doing well at school and hopes to go to university.

Misha Glenny is the author of Nemesis: One Man and the Battle for Rio *(Bodley Head)*

HARDWARE IS...

BRAGI'S IN-EAR ASSISTANT WANTS TO MAKE YOU HEALTHIER AND HAPPIER. BUT FIRST IT NEEDS TO OVERCOME A RAFT OF PRODUCTION PROBLEMS...

BY
DAVID BAKER

PHOTOGRAPHY:
CHRISTIAN STOLL

HARD

The Dash is an in-ear information system designed to let you listen to music, communicate, track your performance and measure your health

From a cramped office in Munich, Nikolaj Hviid is busy creating Europe’s most ambitious consumer hardware product. It’s a device so complex that not even Apple or Google have tried something similar. And its fans love it. Even without seeing it.

The Dash is an in-ear combination of wireless earbud, MP3 player, fitness tracker, personal coach and real-time heart and blood monitor. Its barely promoted Kickstarter campaign reached its initial $260,000 (£170,000) goal within two days and had hit $3.4 million by the time it closed two months later – a then European record. The company now has 600,000 orders on its books.

The trouble is, the project is running late. Early supporters were promised finished units in October 2014. Instead, the company behind The Dash, Bragi, is hoping to ship its first batch 12 months later. And, almost daily, it is discovering extra challenges that have surfaced as production levels have increased. Microscopic cracks have appeared in the product’s ultrasonically welded casing that let in water; and a large amount of (externally written) software has arrived late and full of bugs. Some of Bragi’s challenges are those faced by any European startup with an eye on going global, but many come from the fact that making physical things is a lot more difficult than designing an app.

“It is tough to make hardware,” says Hviid, an amiable 41-year-old Dane, in an accent that hovers between Denmark, the UK, the US and Germany. “When you ship it, it has to be right. You can’t just do an update and you are fine.”

The Dash is an in-ear personal assistant. Tap and slide the touch-sensitive pad on your right ear, and you can flick through a library of 1,000 MP3s, switch between ambient and noise-cancelling modes and take or reject a phone call. Do the same on your left, and you can be coached in real time through a run, swim, cycle or workout, with audio updates on measures such as your pulse, respiration rate and blood-oxygen levels.

It was inspired, says Hviid, by a conversation that he had with his sister, who died from multiple sclerosis in 2013. “She was diagnosed when she was 20,” he says, “It was the day before Christmas. And it got bad quite fast. She was soon in a wheelchair. But, even though she felt shit, she was a happy person. I asked her why, and she said, ‘I know that, every day I live, the next day is going to be worse than today, so today is officially the best day of my life. And you know what, Nikolaj? It is the same for you. But your perspective is slightly longer than mine.’ Since then, I have been thinking about how to help everyone get the best out of that single day.”

In many ways The Dash and Google Glass perform similar functions – acting as intimate personal assistants, giving you the information you need when you need it. But, for Hviid, Google Glass is, literally, too in your face.

“If you want to help people while they are doing something, it has to be a discreet interface,” he says. “It can’t take their attention away from what they are doing. Vision has the opposite effect. It works as a serial interface. So, while you look at me, you have no idea what happens over there. And when you see something, you dive into it. Everything else has gone.”

Hearing, he says, is “completely different. It is a parallel interface. You hear everything at the same time. So, if you want to make a discreet personal assistant, the ear is better than the eye.”

The word “discreet” comes up often in conversations at Bragi. Although the company now has its fair share of geeky jobs (and job titles – staff members are called things like “Master of wires” and “Ultra-low-power guru”), many of its staff share Hviid’s slight discomfort with technology.

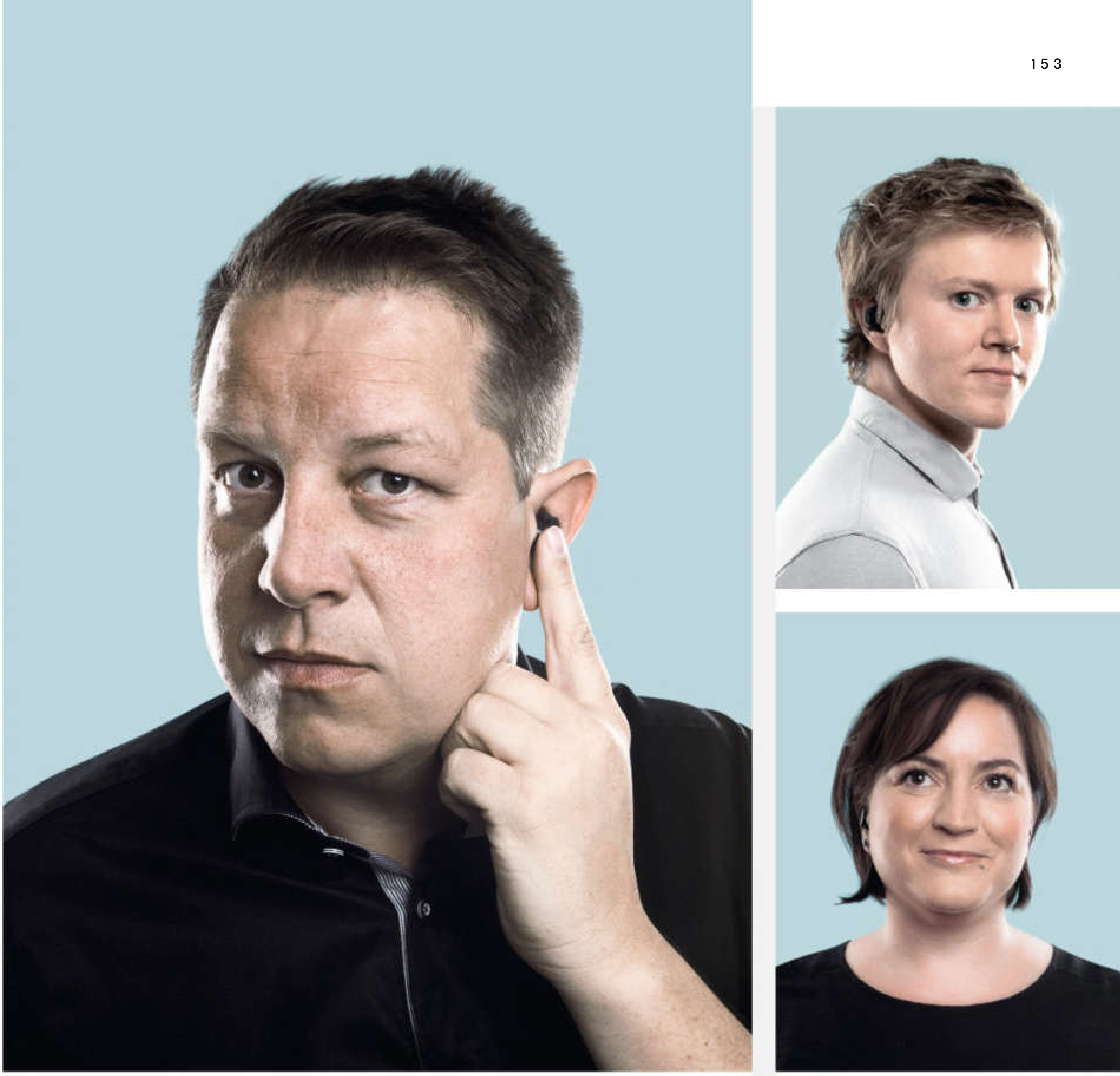
“I am a technology sceptic rather than a optimist,” Hviid says. “I see the opportunities of both but I don’t see a techno future; I see a human future.” And it is this attitude that has made it such a hot place to work. Katia Riley, 33, joined in February as an industrial-design intern, having studied design at the University of Applied Sciences in Berlin. “I saw a presentation by Mairjo [Sarac, chief marketing officer] and immediately wanted to work for Bragi,” she says. “I like the way The Dash integrates technology into our lives without separating us from each other. At the moment, technology does just that. If you are on your smartphone, I don’t feel I can talk to you. However, if you wear The Dash, I don’t feel like I can’t communicate with you.”

It may be, of course, that they are listening to something else entirely – an adult version of trying to talk to a teenager with their headphones on. Riley laughs.

“I guess you’ll have to trust them on that.”

‘If you want a discreet personal assistant, the ear is better than the eye’

PHOTOGRAPHY (PREVIOUS SPREAD): STEPHEN LENTHALL



Clockwise from above:
Nikolaj Hviid, Bragi CEO;
Friedrich Foerstner, head of sensors;
Karin Schlierenkämper, head of hardware

The Dash is likely to have ambitiously strong audio capabilities. (At the time of going to press, Bragi had been unable to provide a model for testing.) Two chip-based microphones in each ear will pick up external sounds and the user's voice – the latter from the bones in the skull. High-end in-ear speakers will ensure the incoming sound remains crisp. And the 100mAh LiPo battery will deliver up to four hours of music in a single charge.

But that is only the start. The Dash will use its own operating system, running on a 32-bit ARM processor (with access to 4GB of flash memory), to collect, clean, sort and interpret data from a cluster of sensors that Hviid's team has designed into the device – all in real time. These will collect not only Fitbit-type movements (steps, running speed and so on) but, boldly, data points from inside the body, such as pulse, respiration rate and blood oxygen levels.

The point of all these components, says Friedrich Foerstner, Bragi's head of sensors, is to give the device a sense of the context around it, of what its wearer is actually doing.

"Movement is what defines a human being," says the 36-year-old. "We can't record thinking too well, not in such a small device, but we can understand things from your movements and actions."

At its simplest level, The Dash will be able to detect what activity its user

WHAT THE DASH INTENDS TO DELIVER

HEALTH TRACKER
- Heart rate
- Heart-rate variation
- Oxygen saturation
- Body temperature
- Calories burned

COMMUNICATOR
- Dual-Mode
- Bluetooth 4.0
- Ambient mic

FITNESS TRACKER
- Distance
- Speed
- Steps
- Cadence
- G-force
- Rotation
- Altitude
- Drop rate

AUDIO PLAYER
- Music playback from The Dash or a smartphone

System engineer Marius Knothe works on a power regulator

is engaged in – initially, running, walking, swimming or cycling, but with more activities to come. Two chip-based inertial-measurement units (IMUs) will convert head movements into more useful measures such as distance travelled, speed, steps taken, pace and rotation. (Distance and speed will rely on user calibration because The Dash won't have GPS capability – "it's too energy-consuming," says Foerstner, "and there's a problem with the size of the antenna.") Customers will also be able to make customisable head gestures to control the device – nodding, for example, to take a call, or looking up to read a text.

Each unit will also feature a set of LED-based sensors to monitor body vital signs. This is where it gets tricky.

"The IMU can give you a context, how you behave and so on," says Foerstner. "But we also want to look inside you and look at your body in relation to the movement. The heart is one of the most crucial measurement points for that. How it reacts to movements and activity lets us understand a lot about your condition."

The Dash uses two LEDs – one red and one infrared – intended to monitor pulse, blood flow and blood-oxygen levels. These fire pulses of light, 50 to 100 times per second, through the thin skin on the inside of the ear and into the capillaries, which then reflect them back. Fuller capillaries (caused by the heart contracting) reflect light differently to capillaries that are relaxed, allowing The Dash, in theory, to measure heart rate. Similarly, oxygenated red blood cells reflect light differently to those carrying less oxygen.

This is not new science. It is used every day in hospitals to monitor a patient's pulse and oxygen levels. But hospital sensors, for the most part, are based on transmission, not reflection, and use a clip on the end of the patient's finger to ensure a constant pressure, which is crucial for accurate readings. Because of these differences, some sensor experts have expressed doubt regarding The Dash's ability to gain meaningful readings from an in-ear sensor, but Foerstner is confident that Bragi's approach is the right one. Early models, he says, are performing well against consumer-level sports ECG monitors, and the company is aiming for clinical-level measurements in the future. Issues such as hair length and skin colour don't appear to be distorting the sensors' readings. Pressure, though, is important but that is solved, he says, by The Dash's shape and size. The devices fit snugly in the ear and the final version will ship with four sizes of silicone outers.

Foerstner says that, since October 2014, the company has been testing the devices on "more than 100" people, in trials that have covered walking, running, swimming, cycling and being at rest. It is now expanding trials to a wider user base. (The company declined to share the results of these trials with WIRED, saying they had not yet been properly analysed.)

For Hviid, the point of The Dash's sensors is that they will allow customers to make more sense of what is going on inside their bodies. He chose health and fitness as a starting point, as it is a straightforward sell into an existing market, but he sees almost infinite uses for the device once it has been launched. And he is confident that The Dash will give

DASH USES – NOW AND THE FUTURE

Fitness coach
The Dash can keep tabs on your athletic performance.

Health monitor
Infrared pulses can monitor the wearer's vital functions on the move.

Translator
In the long term, The Dash could translate into the user's language.

Sound filter
If you need silence, the isolation function can cancel noise.

Teacher
The Dash could become a learning platform, providing real-time tutorials.

Some sensor experts have expressed doubt regarding The Dash's ability to gain meaningful readings from an in-ear sensor

HAIR AND MAKE-UP: ANJA FICHTENMAYE.
MODEL: THERESA @ TUNE MODEL MANAGEMENT

more meaningful feedback than most fitness trackers on the market.

"These trackers that just measure your steps are daft," he says. "Why do we want to know how many steps we have taken? What does 8,000 steps mean for *you*? Instead, how about knowing the relationship between your oxygen concentration, the pace you made and the route you took? That's what we are trying to get to. We want to understand the quality, not quantity."

He is also, he says, very aware of the potential dangers of producing such high-quality personal data.

"Whenever you make something, you need to think about the ethical part of what you are doing. If I can understand the context of a person, just by adding sensors, the impact is that someone will know everything you do, every intention, every motivation you have. Maybe not tomorrow, but maybe in 20 years, it will be possible to know everything about you. And if that information is stored somewhere, someone can have access to it."

The Dash will be one of the very few internet-of-things devices that doesn't have to be connected to the internet. Data processing and storage will all be done on board and it will function fully without the need for an external device such as a smartphone.

But doesn't that risk jeopardising the myriad opportunities that big data offers, especially when it comes to areas such as healthcare? Surely the more people there are sharing, the faster we can solve medical problems that so far have eluded us?

He disagrees.

"Statistically, how many do you actually need?" he says. "Do you really need millions of people sharing? I think hundreds of thousands are enough, statistically more than enough. If you do medical studies, none of them are in the millions and very few of them are in the hundreds of thousands. You don't want everyone to give their data. You want some; the ones who agreed to it."

By any measure,

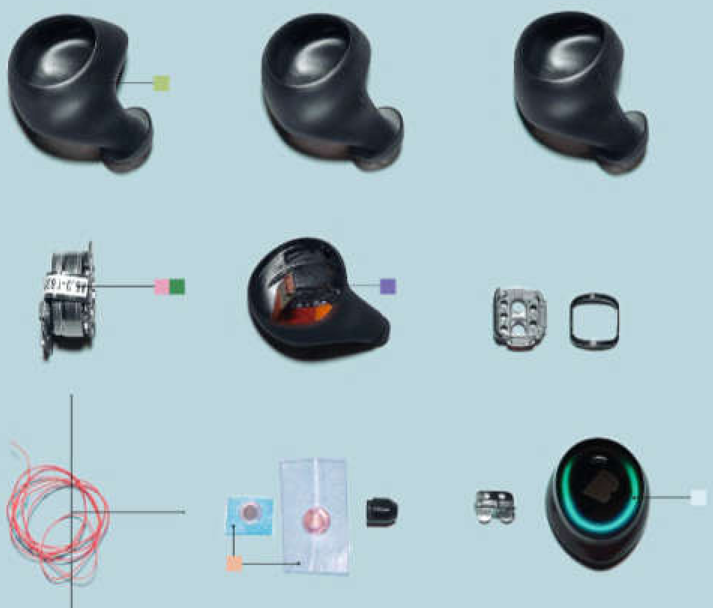
The Dash is behind schedule. When Bragi launched its Kickstarter campaign in February 2014, it planned to be shipping to early investors the following October and to be in full production a month later. Now it hopes to ship the first batch of 15,000 units to Kickstarter investors this month and 10,000 more by Christmas.

In some ways, the company has been overwhelmed by demand. It hopes to fulfil the 600,000 orders by the end of 2016. But Hviid is frank about the difficulties the team has faced developing the hardware and software. In an update on Kickstarter in August 2015 headed "Getting Close", he admitted the previous weeks had been "very intense" and listed a number of mechanical and performance issues that arose as the company moved towards higher production volumes – from 40 units per day to more than 1,000.

"What we are making," he says, "is a small computer that fits inside a dummy, a computer that is as powerful as a laptop was 15 years ago. That was a massive undertaking."

Karin Schlierenkämper, Bragi's head of hardware, shares some details. "The Dash is very tiny and very complex," says the 35-year-old, who joined in March 2015 after working for one of its suppliers. "You have to fit a lot – a computer, two microphones, a speaker, sensors and a power supply – into a space of about a centimetre cubed."

A significant challenge her team faced was how to get the two units to communicate. They originally used Bluetooth, but it doesn't travel well through soft tissue so the team had to beamform the wave behind the user's neck, a tough challenge made worse by the fact that one of the chips they were using consistently underperformed. After a fruitless few weeks, they moved instead, says Schlierenkämper, to an old technology, near-field magnetic induction, used in



WHAT'S INSIDE THE DASH

🟩 **The fit**
The Dash's ergonomically designed silicone sleeves range from extra small to large to fit all ear sizes.

🟩 **The computer**
It is powered by a 32-bit ARM processor; its 4GB flash memory will be able to fit about 1,000 songs.

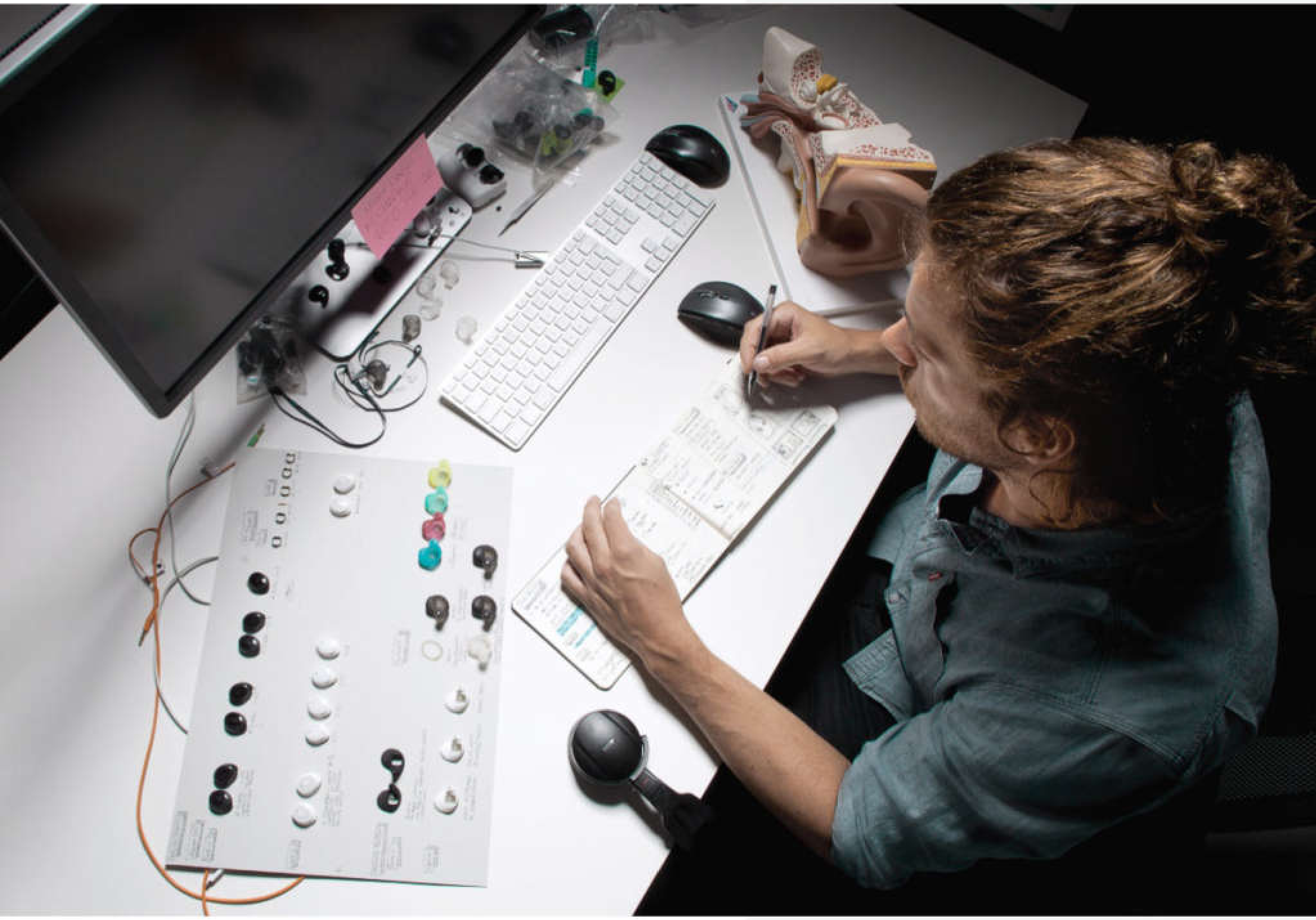
🟥 **The battery**
Bragi expects to use a lithium polymer battery that would fully charge within two hours.

🟪 **The microphone**
To minimise the impact of ambient noise, the microphone listens to your voice from the ear bone.

🟧 **The sensors**
The inertial units track the wearer's movement; the LED-based sensors check on vital functions.

🟦 **The LED**
This blue corona "breathes" every ten seconds. It also gives feedback during calls and other functions.

Arne Loermann, head of design, is responsible for The Dash's casing



hearing aids. They re-engineered it to work in the high-spec environment of The Dash. The problem was solved but the pivot had set the project back yet further. "We had to go back to our supporters and say we weren't going to be able to deliver by October," says Hviid. "We had to say, 'Trust us.'"

Bragi's Kickstarter success insulated the company from needing to raise venture capital. For its first two years it existed on Kickstarter funds plus a large chunk of the Hviids' own cash. ("I'm not saying exactly how much," he says, "but I spoke to my wife and we put in all we had.") In January, he raised $10 million from angel investors, bringing them into the project, he says, partly for their money – the company had faced a serious cashflow issue in 2014 that led to staff taking pay cuts – but more because he feels he can learn from them.

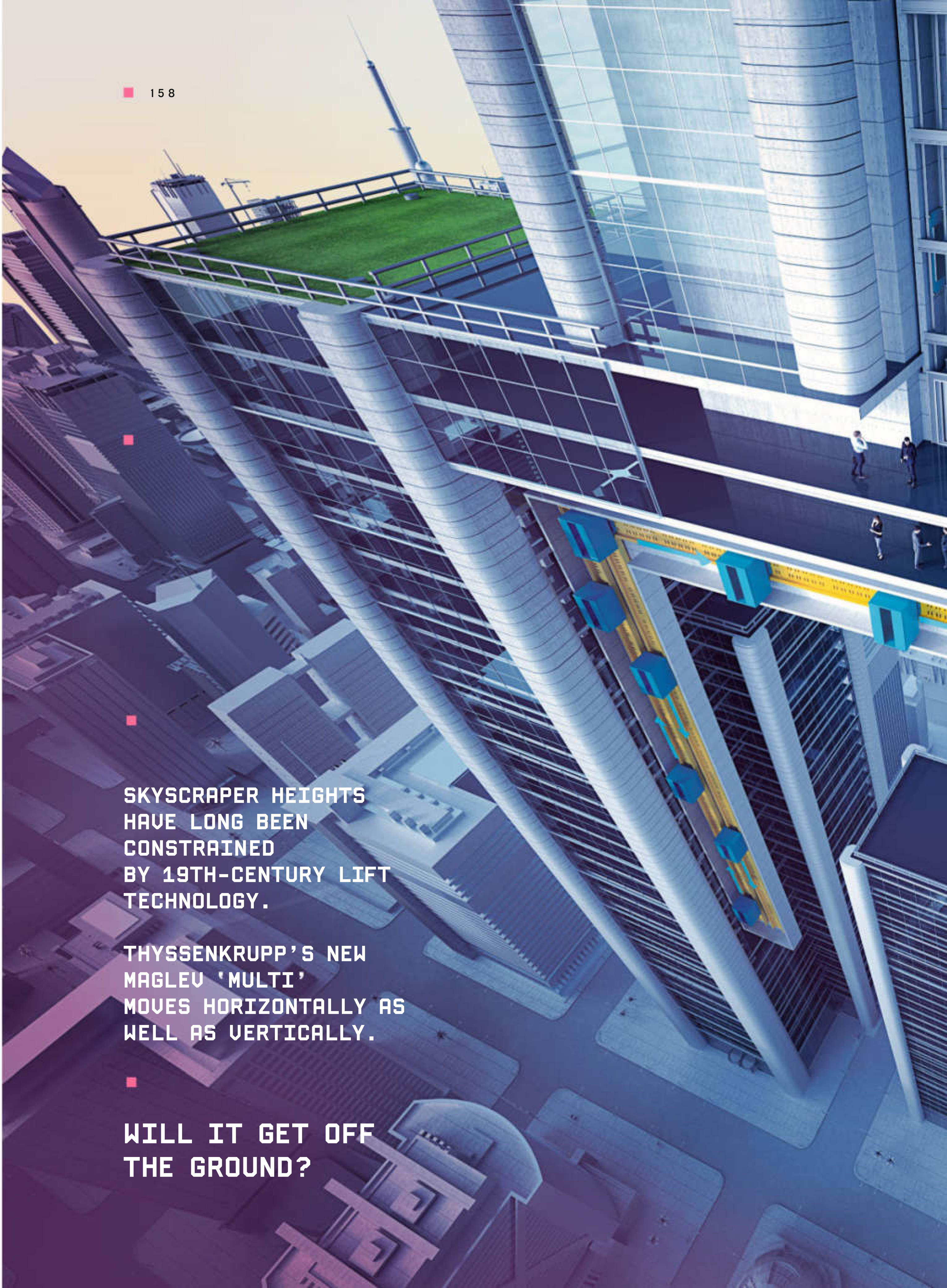
"We had the opportunity to raise funds from people who had a lot of knowledge where I don't," says Hviid. "And it has been so enlightening. When you work closely with people like that, you realise how much further you have to go."

Hviid's goal now, of course, is to start shipping, and the first units should be arriving by the time you read this. But his sights are set into the future.

"This is just the start, he says. "I have created a product that is special and difficult to explain, because it has the potential to do much more than you can see. I would like to provide practical-skills learning through The Dash, for example. Having this device in your ear – maybe connected with something visual, who knows? – can enable people without any formal training to do things they couldn't do before. Someone untrained could be shown how to build a house, for example, and it will protect them when they are doing it. At the moment, we are marketing The Dash as a fitness-and-health device. But when you start expanding into all sorts of areas, such as industrial or medical applications, the entire solutions base becomes more complex."

He pauses and looks out of the window. "We're here for a small fraction of time, so we should be happy and enjoy ourselves. I hope to help people achieve this. Your imagination is never big enough for what we are able to do."

David Baker compiled the Britain Rebooted package in 07.15

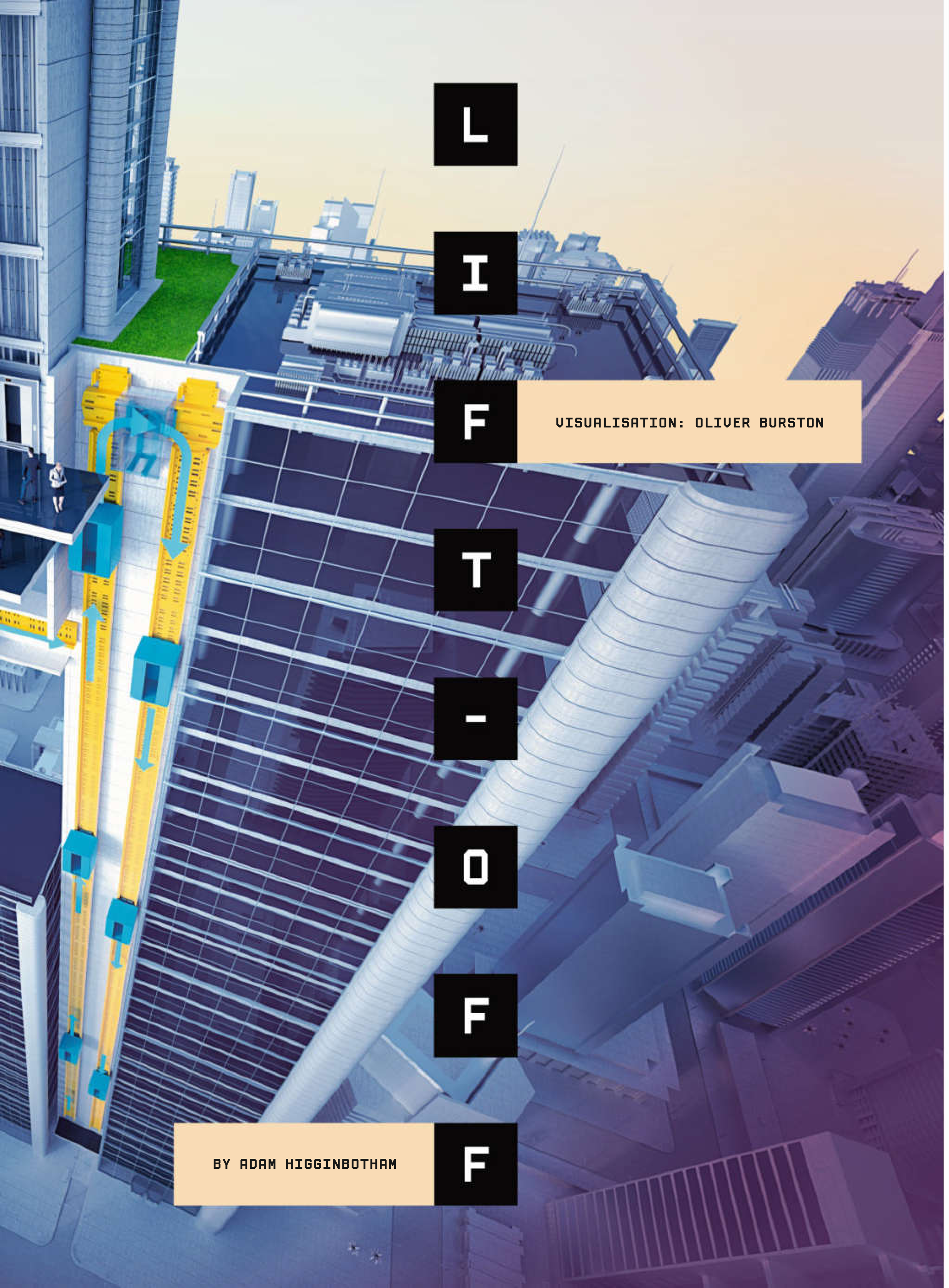


SKYSCRAPER HEIGHTS HAVE LONG BEEN CONSTRAINED BY 19TH-CENTURY LIFT TECHNOLOGY.

THYSSENKRUPP'S NEW MAGLEV 'MULTI' MOVES HORIZONTALLY AS WELL AS VERTICALLY.

WILL IT GET OFF THE GROUND?

LIFT-OFF



VISUALISATION: OLIVER BURSTON

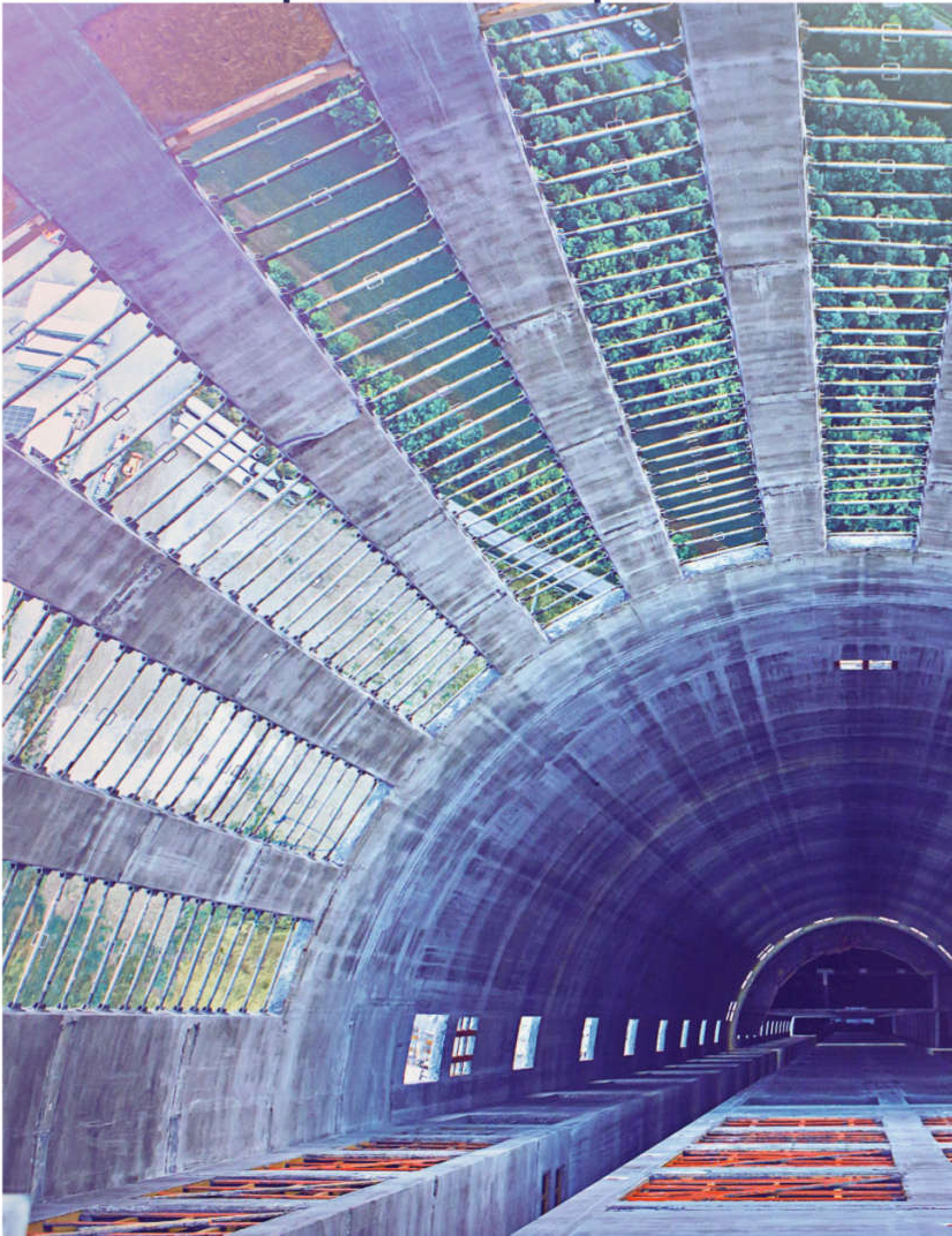
BY ADAM HIGGINBOTHAM

DEEP INSIDE THE CARCASS OF A MONSTROUS CONCRETE TOWER UNDER CONSTRUCTION IN SOUTHERN GERMANY,

Andreas Schierenbeck picks his way carefully across scaffolding boards layered with dust and puddled with water. Wearing a white plastic hard hat, he stoops to avoid dangling cables and timber supports, then stops to point into a narrow abyss at the edge of the platform. "Eighty metres," he warns. "Straight down."

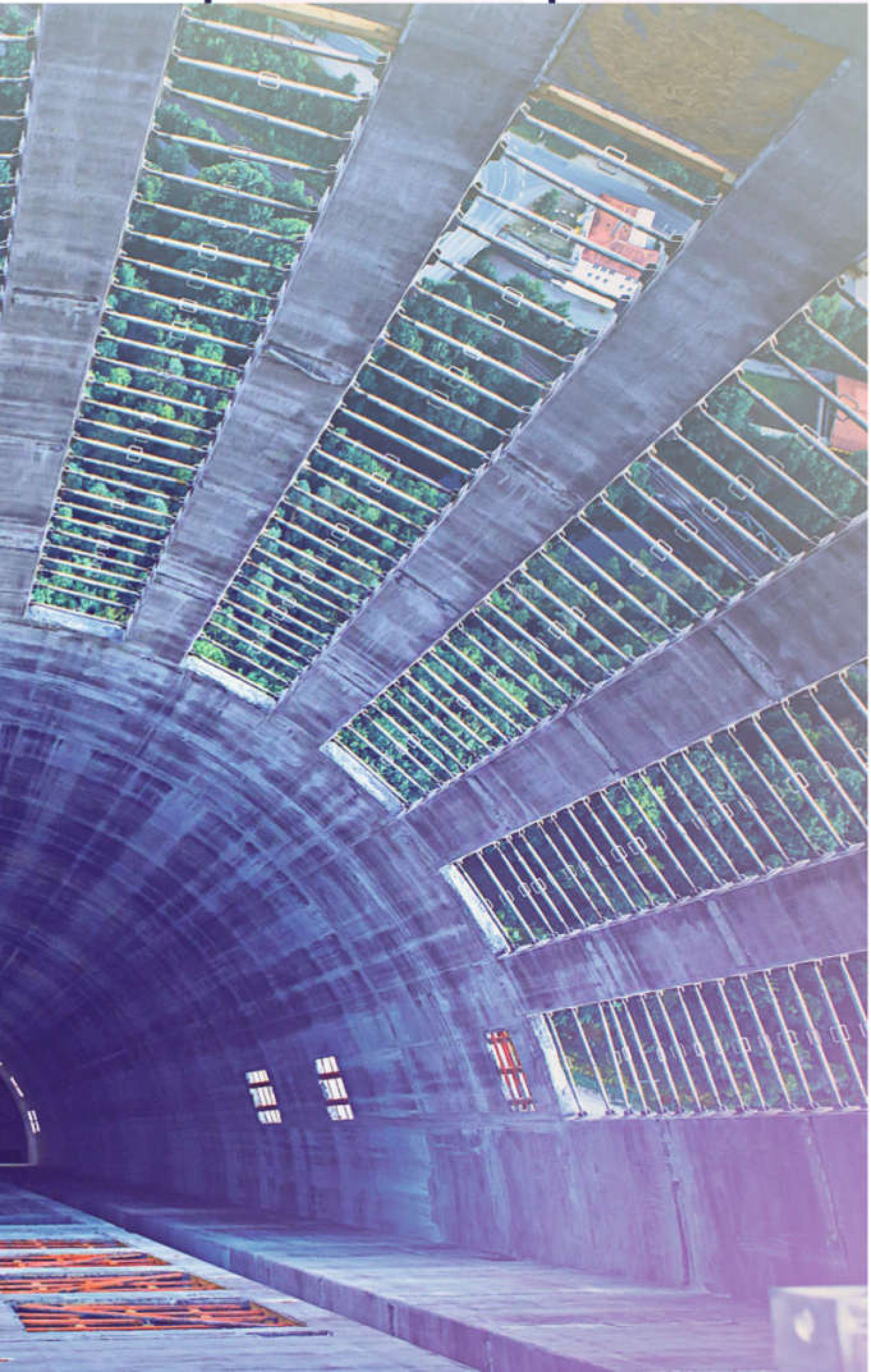
Directly overhead, a construction crew works with deafening power tools, dismantling the forms they've used to mould the most recent layer of concrete, part of a round-the-clock building process that has caused the tower (*pictured*) to rise at more then three metres every 24 hours. When it's finished, Schierenbeck's tower, which is in Rottweil, 100 kilometres south-east of Stuttgart, will reach 244 metres – making it one of the tallest buildings in Germany – and

PHOTOGRAPHY: RALF GRANER



will have the highest observation deck in Europe. It will be sheathed in an elegant corkscrew of pale fabric – almost indestructible, translucent, held under tension like a sail – designed to change colour as the Sun moves across the sky. The architects, Helmut Jahn and Werner Sobek, call the project The Tower of Light.

And yet, even at a total cost of €60 million (£43 million), the building will never be inhabited: Schierenbeck, CEO of multinational conglomerate Thyssen-Krupp's elevator division, intends the Tower of Light for use as a lift test tower, designed to experiment on prototype lift cabs, hoist systems and ropes. The core of the building will contain almost nothing but empty space: nine parallel lift shafts, in which every component of the company's new lifts can be tested – to destruction, if necessary. Pointing into another concrete well yawning below, Schierenbeck explains that the bottom will be reinforced to take the impact of an entire lift cab free-falling at terminal velocity, up to a maximum of 40 tonnes travelling at 160kph.



Yet that isn't the reason Schierenbeck, an electrical engineer with a background in software who arrived in his new position two years ago, has ordered the construction of the Tower of Light. Thyssen-Krupp already has a more modest test centre at its elevator plant, 100 kilometres away in Neuhausen. But that one – like the test towers of each of the company's major competitors around the world – is only designed to accommodate conventional lifts. Schierenbeck has something revolutionary in mind – a lift he calls the Multi, a ropeless version that can move not only vertically, but from side to side. So three of the shafts rising within the tower, specifically designed for the Multi, have no walls separating them from one another. It's within these that he hopes to test a lift that will change the way that the buildings – and thus the cities – of the future will be designed. But before any of that can happen – before his tower can fulfil its purpose; before his startling innovation can redraw the topography of the world's major cities – the engineers at Thyssen-Krupp will have to build a working prototype of the Multi. Schierenbeck admits they haven't managed that yet. But he remains optimistic.

"Otherwise I wasted €60 million – plus the construction of a test tower," he says. "And I'm not prepared to tell my bosses that story."

Lifts have existed in some form almost since the beginning of civilisation. Archimedes recorded his ideas for hoisting devices and, in the 17th century, the German mathematician Erhard Weigel had a pulley system installed in his seven-storey home. In 1804, a six-storey freight and passenger lift was built in a Derbyshire cotton mill, and this was followed by numerous freight lifts installed in factories and mines throughout Europe. All worked on the same simple principle: a car or platform hoisted up and down using ropes, chains and counterweights.

At the Exhibition of the Industry of All Nations in New York's Crystal

Palace in 1854, Elisha Otis gave a public demonstration of a lift safety brake. He instructed an assistant to sever the hoist rope with an axe: the surprise being that the lift did not fall to the ground, but was arrested by a safety catch. The public paid less attention to this than to the "vertical railway" that followed soon after, the invention of an all-but-forgotten mechanic, the confusingly named Otis Tufts. This was the first passenger lift with a completely enclosed cab, which travelled slowly but safely up a shaft on a steam-driven iron screw running through its centre. Only ever installed in two locations, in one hotel in New York and another in Philadelphia, Tufts' lifts proved longstanding tourist attractions. Others raised on hydraulic rams followed, but these could reach only a limited height, and were eventually supplanted by electrically operated traction lifts.

In 1931, the Empire State Building, with a core of 64 lift shafts serving 102 storeys of office space, became the world's tallest building. All of its lifts, controlled by an individual operator who travelled inside the car, were suspended from six or eight hoist cables wound around an electrically operated drum, or sheave. A counterweight, about 40 per cent heavier than the empty car, ran on its own rails to assist the lift's ascent, and emergency brakes tripped by a separate governor cable could slow the car to a gradual stop in the event of a runaway descent.

Simple and beautifully energy-efficient, the version of the traction lift installed in the Empire State was the state of the art in lift design – and would remain so, virtually unchanged, for the next 60 years. This created a technical bottleneck in urban development, because it limited the number of people who could move through a building at any one time. As architects began conceiving taller and taller new buildings, they found themselves hobbled by the limitations of a means of transport that had apparently reached its ultimate iteration in the 19th century. "It's an interesting industry because it's really very old," Schierenbeck says. "It really developed at the same time as electricity was coming in vogue. If we're talking about industry 4.0, this is industry 1.0."

Engineers use the interactive 3D model of the Multi's mechanism at the University of Stuttgart

Today, the industry is dominated by five major manufacturers: Otis, which has grown from Elijah Otis's family firm to become the largest lift manufacturer in the world; Schindler; Kone; Mitsubishi; and ThyssenKrupp, a relative newcomer that entered the field in 1954. For decades, they have been engaged in a battle characterised by incremental improvements in technology and competition for the bragging rights for lift contracts in the world's tallest buildings – especially with the new supertall towers, including the Burj Khalifa in Dubai (Otis) and the Shanghai Tower (Mitsubishi).

The battle has been confined to speed: "The thing to do for building designers is to build the world's tallest towers," says James Fortune, one of the leading independent lift consultants. "The thing for elevator designers is to build the fastest elevators." Schierenbeck intends to ignore this vertical grand prix – and overtake his competitors by abandoning the course altogether.

Installing the correct number of lifts in a high-rise building is a delicate and arcane task. "It's all based on people," says Fortune, who has spent more than 40 years advising architects and developers on lifts for high-rise buildings, including Burj Khalifa and the Kingdom Tower in Jeddah which, when complete, will be the tallest skyscraper in the world. To keep tenants happy, there must be plenty of lifts available. But to keep landlords satisfied, there cannot be so many lifts installed that the shafts and machine rooms necessary to accommodate them gobble up too much of each floor's valuable footprint. In very tall buildings, this balance is complicated further by the tensile limitations of wire rope: a single elevator can climb no higher than 520 metres, above that and the rope it's suspended from becomes too heavy to bear its own weight. Beyond 1,000 metres, a length of wire rope will snap. But, in the early 70s, the designers of the

GOING UP: THE HISTORY OF LIFTS

Mechanical lifts have existed for centuries, but the version we know only appeared with the arrival of the safety brake, and the shift from steam power to electricity, in 1895. Since then, the concern of manufacturers has been improving lifts' speed, while keeping the basic, rope-based design in place. This is what ThyssenKrupp wants to change.

EARLY TRY Inventor Elisha Otis gives the first demonstration of a lift fitted with a safety brake, in New York in 1854.

World Trade Center in New York created a compromise solution to the enduring headaches of vertical transportation: the “sky lobby”. Providing transit points for passengers to move from one set of lift shafts to another, the sky lobbies divided the 110-storey towers into three vertical zones, each served by their own lifts; passengers travelling into the upper two zones of the building had to take an express lift to a sky lobby and transfer to a second, local, lift that would take them to their destination. The lifts in the World Trade Center were some of the largest ever built, designed to hold up to 50 people at a time, with doors opening at both front and back to speed up the flow of passengers. But each elevator shaft could still be occupied by only one car at a time, and this continued to cap the pace at which people could be moved up and down the building. Subsequent holders of the “world’s tallest building” title – the Sears Tower in Chicago in 1973, succeeded in 1998 by the Petronas Towers in Kuala Lumpur – introduced double-decker lifts that could serve two floors simultaneously.

For decades, lift engineers had recognised how much more efficient it would be to have more than one car using the same lift shaft. First installed in Britain in the 1880s, The Paternoster – a chain of open-fronted cabins moving on a continuous loop – offered one solution. But because the design placed the weight of all the cars and their passengers on a single overhead axle, it was useful only in low-rise buildings. A similar concept called for a loop of lifts travelling in a spiral around the outside of a building, and in the early part of the 20th century several patents were filed to put two conventional roped lifts in the same shaft. Every one of those patents expired – foundering on the limitations of existing technology to prevent collisions. All the while, lift engineers continued to imagine an even loftier target: a version entirely free of hoists, cables and pulleys. By the 90s, technicians at more than one of the world’s lift manufacturers believed that the best chance of creating a truly ropeless lift lay in another technology that had been around in one form or another for more than a century: using linear induction motors to create magnetic levitation.

Now a veteran of lift engineering who has spent his entire 24-year career with ThyssenKrupp, Markus Jetter was just starting work with the company when he spotted a technician struggling with the problems of magnetic levitation. Jetter, a lanky 61-year-old with wire-framed glasses and receding black hair turning to grey, is a lift obsessive. He admits to sneaking away from his wife and three children during family holidays to use apps on his iPhone to measure the speed and comfort of the competition’s more prominent high-rise lift installations. He is so coy about their products that he cannot bring himself to mention the names Otis or Schindler in conversation. Jetter is also rigorous about industrial secrecy: he receives a weekly patent alert that keeps him informed of what the engineers at the other companies might be up to. WIRED asks what he was able to tell his family about what he was working on during the ten years he spent on the Multi programme. “The revolution,” he laughs.

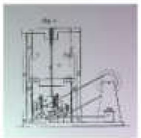
On his introductory tour of the development department in 1991 at the headquarters of the ThyssenKrupp lift division in Neuhausen near Stuttgart, Jetter noticed an engineer sitting at an empty desk with a laptop: he was attempting to apply the principles of maglev railway technology to vertical transport. The company was already a leader in the maglev field, having been at work on a high-speed maglev train – the Transrapid – since the early 70s, and had already built several passenger-carrying prototypes.

Jetter recognised that propelling a train horizontally down a track, hovering on a frictionless electromagnetic cushion – and up the occasional mild incline – was a very different proposition to levitating a fully loaded steel lift car up a shaft. But eventually, in 2000, the ThyssenKrupp engineers built a successful small-scale prototype at the University of Aachen in the Netherlands that could lift its own weight using linear induction. “From that point,” Jetter says, “many in our company considered linear drive to be possible: ‘We can do it! We can see it! We have this prototype!’”

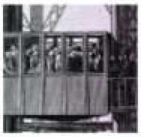
Yet there remained many profound problems that had to be solved before the experimental system could be scaled up to carry passengers. Traction lifts are built from steel for reasons of strength and safety and, because it helps create a stable and comfortable ride, are often better the heavier they become. But a levitating lift car needs to be constructed from something both very lightweight and extremely strong; at the time no such material had been tried. Even more importantly, although a linear drive lift promises to be entirely ropeless, the engineers had no means of ensuring two or more of them could safely share the same shaft without the risk of collision. “It wasn’t possible,” Jetter says. “There was a missing link in the technology.”

While ThyssenKrupp’s maglev lift languished on a drawing board in Germany, across the Atlantic Otis had already filed patents on a new concept they called Odyssey. This was a reimagining of the original

BY THE 1990S, LIFT TECHNICIANS BELIEVED THAT THE BEST CHANCE OF CREATING A ROPELESS LIFT LAY IN ANOTHER TECHNOLOGY – MAGNETIC LEVITATION

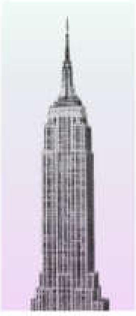


COMPETITION
Other models appear, like the steam-driven “vertical railway” (*above*) and The Paternoster, a chain of cabins on a loop. The electrical traction lift triumphs.



MODERN LIFE
In the US, lifts become widespread by the end of the 19th century. With steel frames, the safety lift brings about skyscrapers and the development of the modern city.

PHOTOGRAPHY: CORBIS



EMPIRE STATE The then world's tallest building, the Empire State Building is completed in New York in 1931. Its 102 floors are served by 64 lifts.

sky-lobby idea, also using linear-induction motors. ("You will find everybody in the elevator business who wants to omit the ropes, they say the only way is a linear drive," Jetter says. "That is common sense.")

In the Odyssey system passengers would sit in enclosed "transit pods" that could travel across the lobby on a horizontal track before being carried to their final destination by one or more conventional lifts. Passengers would climb into the transit pod on the ground floor, which would then move under its own power into a lift; on arrival in the sky lobby, the pod would then travel into a second lift to rise horizontally towards its destination where the passengers would finally disembark. Otis built a prototype but, complex and expensive, it never made its way into production and was finally shelved after the 1997 Asian financial crisis.

In the meantime, one of the missing links that had held back ThyssenKrupp's ropeless solution had been filled in by its competitors. In 1996, Schindler pioneered the use of microprocessor-controlled smart lifts, in which "destination dispatch" software cuts down the number of stops each lift makes.

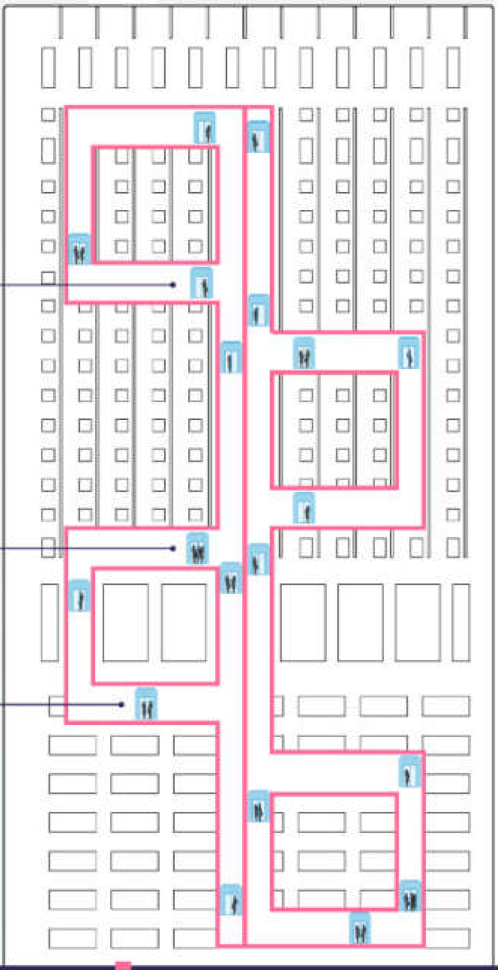
Destination dispatch lift cars contain no buttons at all; instead, each passenger selects the floor they're heading for from a keypad near an elevator bank. Then an algorithm groups together passengers sharing similar destinations and chooses a lift for them to share, thus reducing journey times.

The foundation of destination dispatch control – soon adopted by all major manufacturers – is that each smart lift must know its position in its shaft relative to all the others in operation. For the first time, this meant that two lifts could potentially occupy the same shaft.

In 2000, a team of four ThyssenKrupp engineers went to work on the final stage necessary to make the idea a commercial reality: an electronic system to manage the distance between cars and ensure they never came too close to one another. Not only was this the key to a truly viable two-cabin system, but – because everything else about the idea had been imagined at least 70 years earlier – it was also the one part of the technology the company could patent. In 2003, having devised a proprietary system of proximity control with an algorithm, bar codes and magnetic tapes, the company marketed the Twin lift system.

Jetter and his team turned their attention to the future. "What," he asked, "is the next step?" They returned to thinking about linear drive motors and lightweight carbon-fibre ropes that could extend the height of traditional lifts.

Progress was slow. The engineers were happy to work on new ideas, but according to Schierenbeck few of them believed that anything truly revolutionary was possible. "We are a very traditional industry," he explains. "Very, very conservative."



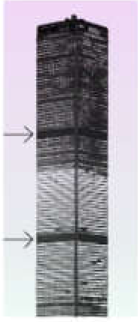
Multiple cars can share each shaft

Capacity is increased and wait times cut

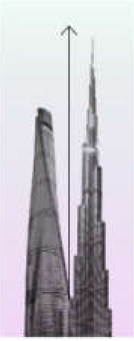
By changing direction, lifts are flexible

HOW THE MULTI NAVIGATES A BUILDING

ThyssenKrupp's new project aims at getting rid of cables and counterweights by using "maglev" railway technology to build a ropeless lift. In the same way that trains slide along a track, this new lift would shoot up the building riding an electromagnetic field. But maglev would allow for more than just vertical travel: when a lift reaches a transfer station, it could move horizontally to another shaft. Lift shafts would be transformed into complex, railway-like networks.



SKY LOBBY
As a lift's ropes only have an effective range of 520 metres, the Empire State holds the height record for four decades. In 1969, the introduction of the "sky lobby" makes taller buildings possible.



STANDSTILL
Since then, the sector hasn't seen much technological innovation. The industry is dominated by five giants – Otis, Kone, Schindler, Mitsubishi and ThyssenKrupp – competing over the contracts for today's tallest buildings.

PHOTOGRAPHY: ALAMY; GETTY

Soon after he arrived at ThyssenKrupp Elevator from Siemens at the end of 2012, Andreas Schierenbeck chaired his first annual innovation meeting at the company's headquarters. ThyssenKrupp Elevator has grown largely through acquisitions of smaller lift companies. It now maintains four semi-autonomous idea labs around the globe, each housing 20 to 30 technicians who often collaborate with teams of university researchers.

At the meeting, he took reports from every one of the company's innovation centres; each one outlined their projects in development and associated budget requests. "We approved every single project, and there was still money left," he says. This meant only one thing: "We didn't have enough ideas." Schierenbeck was shocked. He needed to commit his company to a technological leap, and he wanted to do it quickly. His engineers knew from examining the patent landscape that in Finland, Kone, like them, was already at work on developing a lightweight rope that might take lifts higher than ever. But as far as they could tell, nobody else was working on multiple cabs in a single shaft or linear motors. Schierenbeck told the innovation teams to concentrate on building a prototype ropeless lift.

> 'WE APPROVED EVERY SINGLE PROJECT,AND THERE WAS
> STILL MONEY LEFT,' HE SAYS.THIS MEANT
> ONLY ONE THING: 'WE DIDN'T HAVE ENOUGH IDEAS'

At the beginning of 2013, in ThyssenKrupp's German research centre in Pliezhausen, Markus Jetter's team set to work combining the work they had done on the Twin – the proximity-management software and other safety systems that made it safe to run multiple cars in a shaft – with linear motor technology. The engineers grew ten or 20 decision-tree branches for every component of the system – more than 100 in all. They produced a car within a viable weight budget and devised a passive electromagnetic braking system to arrest the cabin safely in the event of a power failure. The greatest challenge remained how to transfer the car from one shaft to another. They considered 20 solutions for this "exchanger", including a cage designed to capture the lift car at the end of its vertical run and then carry it horizontally, driven by a second propulsion system.

To make the final decision, the team built a pair of one-third-scale mock-ups of the two best exchanger concepts, and in September 2014, the company's research and development council – some 30 managers and engineers – was summoned to Stuttgart from around the world to select a winner. There was little debate: one of Jetter's concepts had proved so complex and difficult that it had been hard even to complete the mock-up; it didn't receive a single vote. But the other exchanger seemed superficially simple: the car was propelled by the linear drive along a track until it reached a transfer station. At that point, a section of the track itself turns through 90 degrees, to allow for horizontal movement into a parallel shaft. The cab then travels horizontally under its own power until it reaches the second shaft, where the receiving track rotates once more to the perpendicular, and the cab continues on its vertical journey. This would make it possible for lift cabins to be treated like train carriages: they could move anywhere and in any direction within the system, and more cars could be added to it for use at peak times, or easily removed for maintenance.

With this piece of the technology finally in place, Schierenbeck gave the go-ahead to build the gigantic €60 million test tower. In November 2014, ThyssenKrupp finally made an announcement about the Multi: "The era of the rope-dependent elevator is over," read the press release, describing a technology that would enable architects to design buildings with previously impossible floorplans, and super-high-rises now navigable by Willy Wonka-style elevators that could travel up, down and sideways – even diagonally. It was, according to ThyssenKrupp, the industry's ultimate goal.

With the Tower of Light due for completion by the end of this year, Schierenbeck hopes to have a full-sized prototype of the Multi ready for test there in 2016.

Elevator consultant James Fortune is not so sure. "They're on the right track – that would be the ultimate lift," he says. "But they've got a long way to go." Fortune believes there remain too many unknowns with such a concept – it lacks, for instance, the power efficiencies of a traditional lift; it has yet to be shown how many people a maglev motor can carry vertically; and horizontal movement is so disorientating in an enclosed space that passengers might simply fall over when the car stops. "It's not a perfected system," Fortune says. "I'd say they're ten years away – minimum."

Meanwhile, Kone is planning to install its strong, lightweight carbon-fibre Ultrarope in lifts serving the Kingdom Tower, helping them become the highest single-drop lifts in the world. Mitsubishi plans to take the prize for Earth's fastest lift with those it is installing in the Shanghai Tower, which it claims will reach 64kph. But for Andreas Schierenbeck these feats are just a sideshow. "It's not solving all the limitations of that technology," he says. "You still have one cabin in the shaft."

Markus Jetter seems confident his work will pay off. When asked to describe the most crazy and unworkable solutions his team had thrown out during the development of the Multi, he says that the engineers were forbidden to call any idea unworkable. "It's difficult to deal with colleagues who say, 'This will never work, or this is crazy,'" he says. "We call it 'idea crushing'. These are all statements discouraging people."

Just look back in history, he says. "These crazy ideas became thrilling technology."

Adam Higginbotham wrote about Dean Kamen in 08.13

OVERHEARD AT WIRED THIS MONTH

"It's big. This is like the Queen is dead, but in tech" – wired.co.uk editor after Google kills its old serif logo. **"It was just flying around, and then it was, like, 'wyyyyyynnnggh'." "That's the noise?" "That's the noise" – art desk relaying a James Bond helicopter stunt.** "Too old to join the army? I'm too old to join the Chelsea Pensioners" – WIRED's deputy editor suffers a career crisis. **"Either I'm that good, or he had something else to do. Or both?" – freelance sub on receiving a proof with no editor's marks on it.** "I'd never held an iron in my life, and I found it riveting." **"If you change a word, I'll kill you. Joking. [*Anxious grin*]" – WIRED editor to subs after filing his Facebook *Messenger* feature *three weeks* late.**

PREDICTIONS FOR 2016 THIS MONTH

In recognition of our WIRED *World in 2016* preview, the WIRED team has some predictions of our own: **"John Snow will definitely return, probably as a fire/ice zombie."** "WIRED will become an immersive 360-degree experience. As will Council Tax." **"That I will ruin another keyboard. Possibly two."** "Scrolls make a comeback in hipster cafés."

LEARNING TO SKI THIS MONTH

WIRED's product editor, Jeremy White, has been campaigning for an all-ski special of Gear since he joined us – and this month, his wish finally came true. You have to wonder, did little Jeremy, aged six (*left*), ever dream he'd one day have a ten-page section dedicated to his new favourite pastime? Or that he would return to the slopes of Westendorf – the very same place we conducted our exhaustive tests?

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180,188

Number of complaints made in the UK from April 2014 to April 2015 against nuisance telephone calls and spams

1,838

Number of reddit threads that went temporarily offline to protest against the firing of Victoria Taylor, the website's director of talent

FIVE

Number of fines that were issued against the companies responsible for the calls and spamming

136 billion

Number of pornographic videos that will be viewed on mobile devices worldwide throughout 2015, according to Juniper Research

57

Percentage of Facebook's US staff, as of June 2015, who are white

€130m

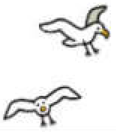
The amount of money the residential and urban areas surrounding Lake Como in Italy would lose every year if George Clooney was to sell his lakeside villa there, according to Camera di Commercio di Monza e Brianza. He is reportedly considering selling up due to paparazzi intrusion

$0.0057

The amount writers on Amazon Kindle's self-publishing platform will receive every time a page of one of their books is read, under the company's new rules. Previously, they were paid per downloaded copy

34

Percentage of Facebook's US staff who are Asian



1880

The year in which female life expectancy started to exceed men's, according to a study published in the *Proceedings of the National Academy of Sciences*. The main cause of decreased male life expectancy was attributed to smoking

193

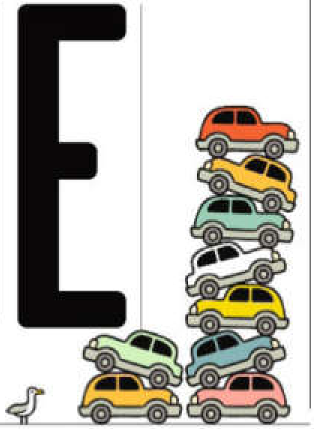
Height, in centimetres, of Blosom, the world's tallest cow, who died in Illinois in June 2015 at the age of 14

2

Percentage of Facebook's US staff who are black

NINE

Number of vehicles involved in a pile-up in Istanbul after a driver hit the brakes to avoid running over a seagull



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